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GRACE ROBINSON HYDE
Chief Engineer and General Manager

July 2, 2018
File No.: 31-300.25

VIA ELECTRONIC MAIL
Ms. Deborah Smith, Executive Officer
California Regional Water Quality Control Board
Los Angeles Region
Attn: Information Technology Unit
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Dear Ms. Smith:

Joint Water Pollution Control Plant
CI No. 1758; Resolution R014-002; NPDES No. CA0053813
<u>Special Studies Final Report Submission</u>

As required under Resolution R014-002, please find enclosed the final report for the following special studies:

1) Palos Verdes Shelf Superfund Site Sediment Core Sampling and Chemical Contamination Characterization (JWSS-14-001).
2) Passive Sampling to Characterize Dissolved Persistent Organic Pollutant Concentrations in the Water Column of the Palos Verdes Shelf Superfund Site (JWSS-14-002).
3) Palos Verdes Shelf Superfund Site White Croaker and Barred Sand Bass Tissue Contamination Characterization (JWSS-14-003).

Unless otherwise instructed by the Regional Board or Regional Board staff, this will be the final submission associated with these Special Studies. 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,

Naoko Munakata
Supervising Engineer
Reuse and Compliance Section

NM:CLT:nm
Enclosures

DMS#4612562

FIRST MONITORED NATURAL RECOVERY REPORT

Data Collections 2013–2016

PALOS VERDES SHELF
OPERABLE UNIT 5 OF THE MONTROSE CHEMICAL CORPORATION SUPERFUND SITE
LOS ANGELES COUNTY, CALIFORNIA

EPA Contract No. EP-S9-08-03
Task Order 0068
Gilbane DCN: 07163.0069.0070

Prepared for:

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Final, May 2018

EXECUTIVE SUMMARY

A sampling and analysis program was conducted at Palos Verdes Shelf (PV Shelf), Los Angeles County, California, in support of monitored natural recovery (MNR), a component of the interim remedy set forth in EPA's 2009 Interim Record of Decision (IROD) for PV Shelf. PV Shelf is Operable Unit (OU) 5 of the Montrose Chemical Company Superfund Site, located in Los Angeles, California.

Background

Montrose OU 5 addresses risks to human health and the environment related to a bed of contaminated solids (sediment) on PV Shelf off the coast of the Pacific Ocean in southern California. In regions south of Los Angeles through the 1950s and 1960s, chemical producers (notably the DDT producer Montrose), discharged industrial wastes to the sanitary sewer system operated by the Sanitation Districts of Los Angeles County (Sanitation Districts). As a result, wastewater contaminated with DDTs and PCBs reached the Sanitation Districts' Joint Water Pollution Control Plant (JWPCP) in Carson, California. The contaminants were transported in the treated wastewater stream (JWPCP effluent) through tunnels under the Palos Verdes Hills to the JWPCP ocean outfall system, and were released to the ocean through the outfall diffusers. The diffusers are located about 2 kilometers (km) offshore, in water depths of about 60 meters (m). Suspended solids emitted from the diffusers formed a bed of "effluent affected" (EA) sediment on PV Shelf. The EA bed is contaminated with DDTs and PCBs. It is encountered at water depths of about 40 m to more than 100 m, and it extends along PV Shelf, parallel to the shore, for about 16 km. The DDTs have spread through the environment and impacted marine animals including fish and birds. DDTs have not been detected in the JWPCP waste stream since 2002, and PCBs have not been detected since 1985. However, these persistent substances remain as chemicals of concern (COCs) for Montrose OU 5.

Interim Record of Decision

In addition to MNR, the IROD set forth two other components of the interim remedy for Montrose OU 5: (1) continuation of the PV Shelf Institutional Controls (ICs) program that includes: public outreach and education to increase awareness and understanding of the existing fish consumption advisories and fishing restrictions; monitoring to evaluate and track contaminant concentrations in fish (primarily white croaker [WC] – a fish known to be impacted by DDTs) caught at or near the site as well as those sold in retail fish markets and served in restaurants; and enforcement of existing commercial and recreational restrictions on WC fishing established by the California Department of Fish and Wildlife (CDFW); and (2) placement of an isolation cap (layer of clean sand) over the most contaminated and erosive area of sediment at PV Shelf. The IROD also promulgated cleanup objectives for the interim cap, and cleanup goals for sediment, for ocean water, and for WC.

Monitored Natural Recovery Program

The objectives of the MNR program included: (1) gathering data to establish the current condition of the sediment bed and compare findings to IROD cleanup levels; (2) supporting the possible remedial design (RD) of the interim isolation cap; (3) gathering data on current conditions of the water column and comparing findings to IROD cleanup levels; and (4) gathering data on current conditions of two COC-impacted fish species, barred sand bass (BSB) and WC, caught in the vicinity of PV Shelf, and comparing COC concentrations in fish tissue (skin-off filets) to IROD cleanup levels and to levels in fish caught far away from PV Shelf. The MNR sampling program included the elements described below.

- Sediment sampling program. Using sampling approaches and techniques similar to EPA's 2009 baseline sediment assessment, sediment cores were collected in October 2013 using a gravity coring device. Sixty-nine primary cores and 10 replicate cores were collected and processed to yield 1,025 samples and 150 replicate samples. Samples were tested for physical parameters including grain size and bulk density, and for chemical parameters including DDTs, PCBs, moisture content (MC), and organic carbon (OC).
- Water sampling using passive sampling devices (PSDs). PSDs including polyethylene devices (PEDs) and solid-phase microextraction devices (SPMEs) were prepared and then deployed at 17 locations along PV Shelf and at one reference location (at 3 or 4 depths per location). The devices were deployed in September 2013 and retrieved in October 2013, then tested for COCs at an analytical laboratory. A total of 207 PSD samples were tested.
- Water sampling for high resolution testing. Grab samples were collected at depth directly into sample bottles from locations along PV Shelf and from one reference location. The bottles were retrieved and sent to an analytical laboratory for testing of COCs using high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS). The high resolution water study generated 137 primary samples and 11 replicates from 40 locations (at 3 or 4 depths per location).
- Fish collection for high resolution testing. Specimens of BSB and WC were caught from several collection areas extending from Ventura in the north to Huntington Flats in the south. The fishing period ran from June 2014 through August 2016; specimens were sent to an analytical laboratory for processing and testing. The catch yielded 301 samples of fish tissue

(skin-off filets; 143 BSB and 158 WC) that were tested for COCs using HRGC/HRMS, and for lipids.

Chemistry testing of all samples was done in conformance with EPA-approved quality assurance project plans (QAPPs). For each medium, COC chemistry results were organized into groupings as follows:

- Total DDTs – the summation of the o,p'- and p,p'- isomers of DDD, DDE, and DDT
- Total DDT Compounds – the summation of Total DDTs plus *p,p*'-DDMU and *p,p*'-DDNU
- Total PCBs (short list) – the summation of 29 individual PCB congeners (used for sediment goals in the IROD)
- Total PCBs (expanded list) – the summation of 46 individual PCB congeners
- OC normalization – for sediment, COC test results were also normalized for OC, in conformance with IROD cleanup goals.
- Bioactive layer – for sediment, COC test results for the 0-8-cm bed-depth interval were analyzed and processed (in addition to the results for the total EA bed), because that interval has been demonstrated to be the bioactive layer at PV Shelf.

For sediment, C Tech's Mining Visualization System was used to estimate average COC concentrations (both dry-weight values and OC normalized values) and total mass, both for the entire EA bed and for the 0-8-centimeter (cm) sediment bed-depth interval.

Results of the MNR Program

For each medium, maximum values were reported for samples collected near or just down-current (northwest) of the diffuser sections of the Sanitation Districts' ocean outfalls, along the 60-m isobath.

Maximum Values of Concentrations of COCs by Medium

Medium	***Total DDTs***	***Total DDT Compounds***	***Total PCBs (expanded list)***
Sediment in 0-8-cm bed-depth interval (milligrams per kilogram [mg/kg])	76 (1,400)	81 (1,500)	6.2 (140)
Sediment in total bed (mg/kg)	310 (6,840)	350 (7,320)	35 (450)
Water using passive sampling devices (PSDs) (nanograms per kilogram [ng/L])	11	13	0.31
Water using high resolution analyses (ng/L)	1.6	3.3	0.19
Fish (micrograms per kilogram [ug/kg])	2,400	3,200	260

Notes
1. The 0-8-cm bed-depth interval in the sediment bed is the bioactive zone at PV Shelf.
2. Units of concentrations match the units used for cleanup goals in the IROD.
3. For sediment, values in parentheses are OC normalized, and may be for different sediment samples.

Sediment results indicated that widespread deposits of DDT and PCB contamination still exist at PV Shelf. For the 0-8-cm bed-depth interval, a DDT hot spot (an area with dry-weight concentrations exceeding 20 milligrams per kilogram [mg/kg]) remains near the center of the diffuser array. A PCB hot spot (an area with dry-weight concentrations exceeding 1 mg/kg) is also present at the same location. Other observations based on the results of the MNR program are:

- In all three media (sediment, water, and fish), p,p'-DDE and p,p'-DDMU are the dominant isomers of DDT. In sediment, these two chemicals accounted for 50% and 30%, respectively, of the mass of Total DDT Compounds.
- Significant amounts of COCs remain in the sediment bed. Patterns of distribution of COCs in the sediment bed at PV Shelf do not appear to have changed appreciably over time. "Hot spot" areas persist near the outfall diffusers along the 60-m isobath. The outfall area (OA), defined as the general area within 1.5 km of the diffusers, contains roughly 47% of the total COC mass.
- For a significant number of primary-replicate pairs of sediment results for Total DDT Compounds and for Total PCBs (expanded list), the relative percent difference (RPD) values exceeded the project goal of 50%; this is likely an indication of the heterogeneity in the sediment bed.
- For water, the values of maximum COC concentrations at nearly every sample location were greatest at the deepest sample depth (i.e., closest to the sediment bed). Based on the results of high resolution grab water sampling, concentrations exceeded applicable IROD cleanup goals (both human health and ecological) at many locations, most notably at the diffusers and down-current (northwest) of the diffusers.
- For fish, the highest values for maximum COC concentrations and for average COC concentrations were reported in samples from specimens caught in the collection areas nearest the outfall diffusers. This trend was observed both for BSB and WC.
- For each fish collection area, the 95% upper confidence limit (UCL) was calculated for both fish species (BSB and WC). The resulting values are regarded as the exposure point concentrations (EPCs) for the collection area. For DDTs in WC, the EPC exceeded the IROD cleanup goal in the outfall diffusers collection area and in the two areas down-current of the diffusers. For PCBs in WC, the EPC exceeded the IROD cleanup goal in the collection area at the outfall diffusers and at the area immediately down-current. There are no IROD goals for BSB.

Time Trends

Results for each medium were compared to results from previous investigations at PV Shelf.

DDTs in Sediment. Results from EPA's previous sediment sampling event conducted in 2009 were compared to results from the 2013 event. For Total DDTs in the upper 8 cm of the sediment bed, the respective mean concentrations (average concentrations based on output from the geostatistical model) were 56 mg/kg OC and 77 mg/kg OC. The respective mass estimates of Total DDTs for the upper 8-cm interval were 1.7 metric tons (MT) and 3.6 MT. The respective estimates of mass of Total DDTs for the entire EA bed were 14 MT and 42 MT. The apparent increases in concentrations and total mass were attributed primarily to the heterogeneity of the sediment bed. However, the mass values for both events are significantly less than historical estimates from researchers in the 1990s.

- PCBs in Sediment. Results from EPA's previous event conducted in 2009 were compared to the 2013 event, using the short list of 29 congeners. For Total PCBs in the upper 8 cm of the sediment bed, the respective mean concentrations (average concentrations based on output from the geostatistical model) were 3 mg/kg OC and 5 mg/kg OC. The respective mass estimates of Total PCBs for the upper 8-cm interval were 0.11 MT and 0.28 MT. For the entire EA bed, the respective estimates were 1.0 MT and 2.9 MT. As with DDTs, the apparent increases in concentrations and total mass were attributed primarily to the heterogeneity of the sediment bed.
- DDTs in Water. Results from a 1997 (high volume) study conducted at PV Shelf by the Southern California Coastal Water Research Project (SCCWRP) indicated that Total DDTs were about 5 nanograms per liter (ng/L) for samples collected along the 40-m and 60-m isobaths, near the ocean bottom, and at locations near the outfall diffusers. This MNR high resolution event showed results ranging from about 0.01 to 1 ng/L for these locations/depths. The corresponding PSD results (2010 and 2013) were higher, ranging from about 3 to 7 ng/L. Rigorous data comparisons and time trend analysis were not possible, due to variabilities in sample collection methods, analytical methods, ocean currents (mixing), and, for PSD events, uncertainties regarding equilibrium dynamics and COC partitioning between the sampling device and the water column, and temperature effects.
- PCBs in Water. Results from the SCCWRP study indicated that Total PCBs were in the range of 0.4 ng/L for samples collected along the 40-m and 60-m isobaths, near the ocean bottom, at locations near the outfall diffusers. This MNR high resolution event showed results ranging from about 0.005 to 0.1 ng/L for these locations/depths. The corresponding PSD results (2010 and 2013) were higher, ranging from about 0.03 to 0.1 ng/L. Similar to DDTs, rigorous data comparisons and time trend analysis were not possible, due to variabilities in sample collection methods, analytical methods, ocean current (mixing), and, for PSD events, uncertainties regarding equilibrium dynamics, COC partitioning between the sampling device and the water column, and temperature effects.
- DDTs in Barred Sand Bass. A 2002/2004 study jointly conducted by the National Atmospheric and Oceanic Administration (NOAA) and EPA (collections from August 2002 to June 2003), indicated that the average concentration of total DDTs in BSB caught in the area closest to the outfalls, was 880 micrograms per kilogram (ug/kg), and 300 ug/kg for fish

caught off Bluff Cove/Palos Verdes Point (about 10 km northwest of the outfalls). BSB results published by the Sanitation Districts in 2014 (collected from June to October 2012) were 130 ug/kg and 65 ug/kg for these areas, respectively, and 70 ug/kg for BSB caught off Long Point/Point Vicente (about 5 km northwest of the outfalls). Results from this MNR event (June 2014 to August 2016 collections) showed values of Total DDTs in BSB to be 290 ug/kg, 97 ug/kg, and 140 ug/kg for these areas, respectively. Rigorous data comparisons and time trend analysis for DDTs in BSB were not possible, due to variabilities in sample collection methods, analytical methods, and uncertainties regarding fish age, mobility, and foraging habits.

PCBs in Barred Sand Bass. The 2002/2004 NOAA/EPA study indicated that the average concentration of PCB congeners in BSB caught in the area closest to the outfalls was 98 ug/kg, and 40 ug/kg for fish caught off Bluff Cove/Palos Verdes Point. Based on the most recent available Sanitation Districts BSB data for total Aroclors published in 2014, results were lower than for NOAA and above the data from this MNR report, at 67 ug/kg and 17 ug/kg, from these respective areas, and at 31 ug/kg for BSB caught off Long Point/Point Vicente, about 5 km northwest of the outfalls. Results from this MNR event showed values of 35 ug/kg, 16 ug/kg, and 23 ug/kg for these areas. Rigorous data comparisons and time trend analysis were not possible, due to variabilities in sample collection methods, analytical methods, congeners versus Aroclor lists, and uncertainties regarding fish age, mobility, and foraging habits.

- DDTs in White Croaker. The 2002/2004 NOAA/EPA study (collections from September 2002 to June 2004) indicated that the average concentration of DDTs for WC caught in the area nearest the outfall was 1,400 ug/kg; and for WC caught off Long Point/Point Vicente, about 5 km northwest of the outfalls, the value was 990 ug/kg. Results from this MNR event (October 2014 to July 2016 collections) showed values of Total DDTs to be 770 ug/kg for both of these areas. Results published by the Sanitation Districts in 2016 (collected in November and December 2015) were 2,900 ug/kg and 1,600 ug/kg, respectively. Rigorous data comparisons and time trend analysis were not possible, due to variabilities in sample collection methods, analytical methods, and uncertainties regarding fish age, mobility, and foraging habits. However, the Sanitation Districts has published fish results since the late 1990s, and the data set indicates a dramatic reduction in DDT concentrations in WC since that time.
- PCBs in White Croaker. The 2002/2004 NOAA/EPA study indicated that the average concentration of PCBs for WC caught in the area closest to the outfalls was 350 ug/kg; for fish caught in the area off Long Point/Point Vicente, the value was 120 ug/kg. Results from this MNR event showed values of 82 ug/kg and 120 ug/kg for these same areas. Results published by the Sanitation Districts in 2016 were 270 ug/kg and 150 ug/kg, respectively. Rigorous data comparisons and time trend analysis were not possible, due to variabilities in sample collection methods, analytical methods, congener lists, and uncertainties regarding fish age, mobility, and foraging habits. However, the Sanitation Districts has published fish results since the late 1990s, and data indicate a drop in PCB concentrations in WC.

Compliance with IROD

Results for each medium were compared to the cleanup criteria set forth in the IROD. As indicated in the table below, though cleanup objectives related to the isolation cap appear to have been met, IROD cleanup goals for sediment, water, and fish have not been met.

Overall, conditions at PV Shelf regarding COC contamination in sediment appear to be improving – concentrations in the 0-2-cm bed-depth interval continue to decline, and concentrations in the 0-8-cm bed-depth interval were lower than the performance objectives related to the interim cap described in the IROD, even without the cap. However, significant areas of sediment remain highly contaminated, and COC concentrations in samples of water and fish exceeded the associated IROD cleanup goals, both for DDTs and PCBs. EPA will continue the MNR sampling program to evaluate the effectiveness of MNR and to develop final remediation alternatives for PV Shelf cleanup.

Summary of IROD Compliance

Medium/COC	***Representative value***	***IROD post-capping objective***	***IROD interim cleanup level***
Sediment (average concentrations)			
Total DDTs (mg/kg OC)	77	78	46
Total PCBs - short list (mg/kg OC)	5	7	7
Total PCBs (mg/kg OC)	10	-	-
Water (human health)			
p,p'-DDE (ng/L)	1.1	-	0.22
Total PCBs (ng/L)	0.19	-	0.064
Water (ecological)			
Total DDTs (ng/L)	1.6	-	1
Total PCBs (ng/L)	0.19	-	30
White Croaker - Outfall Collection Area			
Total DDTs (ug/kg)	1,000	-	400
Total PCBs (ug/kg)	98	-	70

Abbreviations
- mg/kg OC - milligrams per kilogram normalized for organic carbon
- ug/kg - micrograms per kilogram (parts per billion)
- ng/L - nanograms per liter (parts per trillion)

Notes
1. For Total PCBs, all values are for the expanded congener list, unless otherwise noted.
2. For sediment, all values are for the 0-8-cm bed-depth interval (the bioactive zone at PV Shelf). The representative values are the mean (average) OC normalized concentrations as generated by the current output of the geostatistical model.
3. For water, the representative values are maximum concentrations from the current MNR data set. The representative values for p,p'-DDE and for Total DDTs are from the near-bottom sample for location 4C, and the representative value of Total PCBs is from the mid-column sample at location 7C.
4. For fish, the representative value is the exposure point concentration.

Lessons Learned

Difficulties were encountered in duplicating sampling program design and in analyzing time trends, due to inconsistent approaches in past sample collections, laboratory analyses, and data processing. In future MNR monitoring events, approaches to sample collection, laboratory analysis, and data processing should be identical or similar to those used for this MNR study, and the sampling/collection locations used for this study should be reoccupied to the extent practical. This approach will be important for a meaningful comparison of data ("apples to apples") for examining time trends, assessing accurately the effectiveness of MNR, and determining whether COC concentrations have reached applicable cleanup levels.

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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
%	percent
2D	two-dimensional
3D	three-dimensional
ABSG	acid-base silica gel
ALS	ALS Life Sciences Division|Environmental
AWQC	Ambient Water Quality Criteria
BD_d	dry bulk density
BD_w	wet bulk density
BSB	barred sand bass
C-13	carbon 13 isotope
CalEPA	California Environmental Protection Agency
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
cm	centimeter(s)
COC	chemical of concern
CSM	conceptual site model
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DGPS	differential global positioning system
DPH	California Department of Health
DOC	dissolved organic carbon
DQOs	data quality objectives
EA	effluent-affected
EDL	estimated detection limit
eDMS	environmental data management system
ELAP	Environmental Laboratory Accreditation Program
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
Eurofins CS	Eurofins Calscience Laboratories, Inc.
FS	Feasibility Study
FSP	Field Sampling Plan
FYR	5-year review
g	gram(s)
g/cm^3	grams per cubic centimeter
GC	gas chromatography
GCS	Geographic Coordinate System
GC/MS	gas chromatography/mass spectrometry
Gilbane	Gilbane Federal
GIS	geographic information system
GMU	GMU Geotechnical, Inc.

GPC	gel-permeation chromatography
GS	galvanized steel
H:V	horizontal-to-vertical
HRGC/HRMS	high resolution gas chromatography/high resolution mass spectrometry
ICs	Institutional Controls
ID	identification
IRIS	Integrated Risk Information System
IROD	Interim Record of Decision
IS	internal standard
ITSI	Innovative Technical Solutions, Inc.
ITSI Gilbane	ITSI Gilbane Company
JWPCP	Joint Water Pollution Control Plant
K_fV_f	SPME water partitioning coefficient
K_{PEW}	polyethylene water partitioning coefficient
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometers
L	liter(s)
LCS	laboratory control sample(s)
m	meter(s)
m^3	cubic meter(s)
MC	moisture content
MDL	method detection limit
mg/kg	milligrams per kilogram (parts per million)
mgd	million gallons per day
MIV	mass inventory volume
mL	milliliter
mm	millimeter(s)
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
ng/L	nanograms per liter (parts per trillion)
NIST	National Institute of Technology and Standards
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRDA	National Resource Damage Assessment
OA	outfall area
OC	organic carbon
OCP	organo-chlorine pesticide
OEHHA	Office of Environmental Health Hazard Assessment
OU	Operable Unit
p,p'-DBH	bis(4-chlorophenyl)methanol
p,p'-DBP	bis(4-chlorophenyl)methanone

p,p’-DDA	2,2-bis(4-chlorophenyl)acetic acid
p,p’-DDM	1-chloro-4-[1-(4-chlorophenyl)methyl]benzene
p,p’-DDMS	1-chloro-4-[2-chloro-1-(4-chlorophenyl)ethyl]benzene
p,p’-DDMU	1,1-bis(4-chlorophenyl)-2-chloroethene
p,p’-DDNS	1-chloro-4-[1-(4-chlorophenyl)ethyl]benzene
p,p’-DDNU	1,1-bis(4-chlorophenyl)ethene
p,p’-DDOH	2,2-bis(4-chlorophenyl)ethanol
PBL	Portuguese Bend Landslide
PCBs	polychlorinated biphenyls
PE	performance evaluation
PED	polyethylene device
pg/g	picograms per gram (parts per trillion)
pg/L	picograms per liter (parts per quadrillion)
POLA	Port of Los Angeles
POP	persistent organochlorine pollutant
ppb	parts per billion
ppm	parts per million
PRC	performance reference compound
PSD	passive sampling device
psi	pounds per square inch
PV Shelf	Palos Verdes Shelf
PVSTIEG	Palos Verdes Shelf Technical Information Exchange Group
QAPP	quality assurance project plan
QATS	Quality Assurance Technical Services
QC	quality control
QCSR	Quality Control Summary Report
R^2	coefficient of determination
RA	remedial action
RAC	Remedial Action Contract II
RAO	remedial action objective
RD	Remedial Design
RI	Remedial Investigation
RL	reporting limit
RO	reverse osmosis
ROD	Record of Decision
RPD	relative percent difference
RV	research vessel
SAIC	Science Applications International Corporation
Sanitation Districts	Sanitation Districts of Los Angeles County
SCCWRP	Southern California Coastal Water Research Project
SG	specific gravity
SGC	silica gel cleanup
SOP	standard operating procedure
SPME	solid-phase microextraction
SPI	sediment profile imaging
SRM	standard reference material

SWRCB	(California) State Water Resources Control Board
TN	total nitrogen
TO	Task Order
TOC	total organic carbon
Trustees	(state and federal) Natural Resource Trustees
UCL	upper confidence limit
ug/kg	micrograms per kilogram (parts per billion)
um	micron(s)
USGS	United States Geological Survey
Veridian	Veridian Environmental, Inc.
Vista	Vista Analytical Laboratory
Water Board	California Regional Water Quality Control Board
WC	white croaker
WHO	World Health Organization
WQL	Water Quality Laboratory

1.0 INTRODUCTION

The United States Environmental Protection Agency (EPA), Region IX, conducted a sampling and analysis program of various environmental media 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, 20201 Normandie Avenue, Los Angeles, California.

Gilbane Federal (Gilbane; formerly ITSI Gilbane), Concord, California, was EPA's prime contractor for this program conducted under EPA Remedial Action Contract II (RAC) Number EP-S9-08-03, Task Order (TO) 0068. The main purpose of this program is to support monitored natural recovery (MNR) of PV Shelf. MNR is a component of the interim remedy for the site, as described in the Interim Record of Decision (IROD) for Montrose OU 5, signed by EPA in 2009.

To implement the MNR component, EPA gathers data periodically to characterize various environmental media at the site, including sediment, water, and fish; the data may also be used to support the possible remedial design (RD) of an interim isolation cap, a second component of the interim remedy. EPA will also use data from this program to develop the Final Record of Decision (ROD) for PV Shelf.

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 (Sanitation Districts), has sent treated wastewater (effluent) to ocean outfalls at White Point on the Palos Verdes Peninsula. From the 1950s to 1971, the Montrose plant on Normandie Avenue discharged process wastes from the manufacture of dichlorodiphenyltrichloroethane (DDT) into the local municipal sewer system, where the wastes entered the wastewater stream. The wastewater was treated at JWPCP and subsequently discharged to the Pacific Ocean by way of the Palos Verdes Hills tunnels and the White Point outfalls. Details on the White Point outfalls, their diffusers (emitters), and the history of JWPCP emissions are available in the Sanitation Districts' references cited herein (Sanitation Districts 2006, 2012, and 2016). Until polychlorinated biphenyls (PCBs) were banned in 1976, PCBs from various other local industries were also present in the waste stream treated at JWPCP. In 1971, annual mass emissions from JWPCP were estimated at 167,000 metric tons [MT] of effluent solids, containing 21 MT of DDT and 5.2 MT of PCBs (Science Applications International Corporation [SAIC], 2004). Montrose stopped discharging DDT wastes to the sewer system in 1971, but damage to the natural environment, notably the collapse of the California brown pelican population due to DDT-related egg-shell thinning, already had occurred.

Due to DDT contamination, the State of California issued an interim health advisory in 1985 discouraging human consumption of white croaker (WC) fish. Subsequently, 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 WC.

In 1994, five state and federal Natural Resource Trustees (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 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 the 1970s, loading rates of contaminated suspended solids emitted through the Sanitation Districts’ 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) the Sanitation Districts’ secondary treatment of wastewater at JWPCP, which was initiated in November 1983 and fully on-line in November 2002. DDTs have not been detected in JWPCP effluent since 2002, and PCBs have not been detected in JWPCP effluent since 1985 (Sanitation Districts, 2012). Sanitation Districts 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 (Sanitation Districts, 2012).

Since 1994, organizations including the Sanitation Districts and the Southern California Coastal Water Research Project (SCCWRP), have contributed to EPA's understanding of PV Shelf through technical studies. EPA over the years has directly sponsored and funded field studies at PV Shelf, including assessing degradation of COCs, modeling sediment transport, and tracking fish movements. In 2009, as part of the MNR component of the interim remedy, EPA conducted a baseline sampling event of the sediment bed at PV Shelf (ITSI Gilbane, 2013b). The MNR study presented herein is a continuation of the MNR remedy component.

1.2 SITE DESCRIPTION

PV Shelf encompasses a bed of contaminated solids (sediment) emitted from the wastewater outfall system that has settled on the seafloor in the Pacific Ocean at water depths varying from about 40 m to 200 m or greater. The bed of contaminated sediment is situated on the western edge of the North American continental shelf off the Palos Verdes Peninsula in southern California. The distance from the shoreline to the inshore edge of the sediment bed (approximate water depth = 40 m) is about 1.5 kilometers (km). Catalina Island, one of the Channel Islands, is the closest island to PV Shelf, at a distance of about 42 km.

The sediment bed varies in width from about 1.5 to 4 kilometers, and is about 25 km in length. The continental shelf in this area slopes in the seaward direction at about 1 to 4 degrees. A shelf break (i.e., the zone of transition from the relatively flat shelf to the steeper continental slope) occurs at water depths of 70 to 100 m. The seafloor then drops sharply at a slope of about 13 degrees to a water depth of 800 m (Lee, 1994). Figure 1-1 shows the PV Shelf Study Area with bathymetry (depth) isobaths. EA sediment deposits historically have been encountered outside the Study Area on the shelf break and even the shelf slope itself, in ocean water as deep as 500 m (Sanitation Districts, 1992).

Previous researchers have surmised that materials from the Portuguese Bend Landslide (PBL) and other landslides on the Palos Verdes Peninsula have settled on the ocean floor and mixed with the contaminated solids discharged from the Sanitation Districts' 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 (MC); lower mean grain size; lower dry bulk density (BD_d); 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 low values of BD_d and high DDT concentrations is encountered. The thickness of this layer varies along PV Shelf, but appears to be greatest near the diffuser sections of the Sanitation Districts' outfalls.
- Native sediment – Beneath the heavily contaminated sediment lies the native sediment bed; the bed generally is sandy and is coarser and less cohesive than the layers above. It also is further characterized by higher values of BD_d and lower concentrations of COCs and OC.

Investigations have shown that DDT at PV Shelf has undergone significant degradation through reductive dechlorination to form several breakdown products, including p,p'-DDE and 1,1-bis(4-chlorophenyl)-2-chloroethene (p,p'-DDMU), while PCBs have not exhibited biodegradation at PV Shelf (Eganhouse et al., 2008). Figure 1-2 illustrates potential microbial degradation pathways for DDT at PV Shelf, and indicates that p,p'-DDMU and 1,1-bis(4-chlorophenyl)ethene (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 DDTs 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 4.1.2 of this report). The mean concentration of DDTs in surface sediment (non-OC normalized) at the shelf has been reported as 12 parts per million (ppm); the mean concentration of PCBs (non-OC normalized) has been reported as 0.69 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) https://www3.epa.gov/region9/superfund/pvshelf/pdf/pvs-remediation-inv.pdf
- *Feasibility Study* (FS), *May 2009, Palos Verdes Shelf, Operable Unit 5 of the Montrose Chemical Corp. Superfund Site* (EPA, 2009a) https://www3.epa.gov/region9/superfund/pvshelf/pdf/final-feas-study-may09.pdf
- *Interim Record of Decision, Palos Verdes Shelf, Operable Unit 5 of the Montrose Chemical Corporation Superfund Site, Los Angeles County, California* (EPA, 2009b) https://www3.epa.gov/region9/superfund/pvshelf/pdf/PvsIrodFinal.pdf

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.
- Monitor 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. Features of successful cap implementation are described below.
  - The cap would reduce immediately the mean DDTs concentration in shelf surface sediment to 78 milligrams per kilogram (mg/kg) OC.
  - Natural recovery would reduce the mean DDT concentration in surface sediment to an interim cleanup level of 46 mg/kg OC (double the cleanup level of 23 mg/kg OC) by the first post-cap 5-year review (FYR).
  - The cap would reduce immediately the mean PCB concentrations in surface sediment across the shelf to the interim cleanup level of 7 mg/kg OC.

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

- Reduce to acceptable levels the risks to human health from ingestion of fish contaminated with DDTs and PCBs.

  - Achieve the goal of 400 micrograms per kilogram (ug/kg) DDTs and 70 ug/kg PCBs in WC.
  - Maintain the ICs program that aims to prevent contaminated fish from reaching markets and educates anglers on safe fish consumption practices.
  - Achieve the interim goal of mean DDT concentrations in surface sediment of 46 mg/kg OC Total DDTs in surface sediment (double the cleanup level of 23 mg/kg OC) and PCBs of 7 mg/kg OC by the first FYR.
- Reduce to acceptable levels the risks from DDTs and PCBs to the ecological community (i.e., benthic invertebrates and fish) at PV Shelf.
  - Support the Trustees' strategies to sustain wildlife recovery.
- Reduce DDTs and PCBs in water to meet EPA's Ambient Water Quality Criteria (AWQC) as cited in the IROD:
  - Achieve the human health AWQC for DDT (p,p'-DDE = 0.22 nanograms per liter [ng/L]) within 30 years of remedial action (RA).[1]
  - Collect and assess PCB data to determine the schedule to meet human health AWQC for PCBs (i.e., 0.064 ng/L) by the first FYR.
- Minimize impacts to sensitive habitats and biota during cap placement by the following:
  - Develop a monitoring program to protect kelp beds.
  - Use low-impact techniques, measure the speed of ocean currents and COCs in the water column, and monitor sediment resuspension. Stop work if site-specific standards are exceeded.

1.4 OBJECTIVES OF THE SEDIMENT SAMPLING PROGRAM

The area studied during the 2013 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. The *Final Sampling and Analysis Plan for Sediment Sampling, Part 1- Quality Assurance Project Plan* (QAPP; ITSI Gilbane, 2014) provides a detailed description of the project objectives. These are summarized below.

- Determine whether the values for the mass of COCs in the sediment bed are continuing to decrease; i.e., is the trend of recovery indicated by the 2009 sediment results evident?

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[1] The AWQC (ecological) for "DDT and its metabolites" was published in 1980 using guidelines for establishing water quality criteria under Section 304 of the Clean Water Act of 1977. The AWQC (human health) for p,p'-DDE was published in 2002 using methodology for establishing AWQCs for protection of human health (referred to as the "2000 Methodology" [EPA, 2000a]), which incorporated scientific advances in cancer and non-cancer risk assessments, exposure assessments, and bioaccumulation factors in fish.

- Determine whether installation of the isolation cap will be necessary to attain the cap-related cleanup goals stipulated in the IROD.

The desired data include the following:

- Physical parameters pertinent to evaluating (modeling) sediment transport and possibly designing the interim isolation cap. Parameters include grain size (particle size); wet sediment bulk density (BD_w); specific gravity (SG); and MC. Values of BD_w and MC are also used in calculating concentrations of COCs and contaminant mass.
- Chemical parameters pertinent to evaluating the progress of MNR and selecting areas where an isolation cap will be placed. Parameters include concentrations of the prevalent DDT forms encountered at PV Shelf; individual PCB isomers; and total organic carbon (TOC).
- The list of DDTs and their breakdown products include the o,p'- and p,p'- isomers of DDT; dichlorodiphenyldichloroethene (DDE); and dichlorodiphenyldichloroethane (DDD)[2]. These chemicals have been recognized by toxicity databases, including EPA's Integrated Risk Information System (IRIS).
- Additional chemicals of interest for PV Shelf include p,p'-DDMU and p,p'-DDNU, as these have been recognized as DDT breakdown products in sediment at PV Shelf (Eganhouse et al., 2008).
- The PCB congeners of interest for PV Shelf include 46 individual congeners (see Section 2.1.6.2).

1.5 OBJECTIVES OF THE WATER SAMPLING PROGRAM

1.5.1 High Resolution Sampling Program

The *Final Quality Assurance Project Plan – Water Sampling Program* (QAPP; Gilbane Federal, 2014) presents details for the goals and objectives of the project. The objectives of the sampling program conducted in 2015 are summarized below.

- Assess water column concentrations of DDTs and PCBs at very low concentrations for the purpose of evaluating the extents of dissolved-phase contamination.
- Determine whether water column concentrations of DDTs and PCBs exceed the AWQC values presented in the IROD.

The desired data are described below.

- The IROD for PV Shelf states that AWQC for DDTs and PCBs are being considered in assessments of the progress of site cleanup (EPA, 2009). Because these criteria are less than 1 ng/L, EPA determined that high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS) methods would be used for testing water column

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[2] The o,p'- and p,p'- isomers are also referred to as 2,4'- and 4,4'- isomers.

samples at PV Shelf. This sampling event would be the first time that high resolution analytical techniques were used to analyze samples of the PV Shelf water column.

- The analyte lists for DDT isomers and PCB congeners will be the same as for the current sediment program.
- The water sampling locations were to be established at sediment coring locations, and depth profiles would be based on recent deployment depths of passive sampling devices (PSDs).
- The high-resolution data would be compared to water column data acquired by previous PSD sampling programs and other programs that used filtered, high-volume pumped samples.

1.5.2 PSD Program

The *Final Quality Assurance Project Plan for Passive Sampling for Persistent Organochlorine Pollutants (POPs) in the Water Column of the Palos Verdes Shelf (2013)* (Fluen Point Environmental, 2013) presents details for the goals and objectives of the project. The objectives of the sampling program conducted in 2013 are to:

- Assess whether using performance reference compounds (PRCs) addresses the problem of offset in the 2010 results from polyethylene devices (PEDs) and devices with solid-phase microextraction fibers (SPMEs);
- Measure the dissolved concentrations of DDTs and PCBs in different horizons of the water column and along a spatial gradient away from the highly contaminated zone and at stations up-current of the most highly contaminated sediment; and
- Compare dissolved DDT and PCB concentrations to those measured using the same (i.e. PED), and similar (i.e. SPME) methods in 2010.

The desired data are described below.

- Analyte mass in the passive samplers, temperature, dissolved organic carbon (DOC) and salinity will enable the calculation of dissolved concentrations in the water column.
- Contaminants to be measured include congeners of DDT and their breakdown products (including p,p'-DDMU and p,p'-DDNU), and forty-four PCB congeners.

1.6 OBJECTIVES OF THE FISH SAMPLING PROGRAM

The *Final Quality Assurance Project Plan – Fish Sampling Program* (QAPP; Gilbane, 2016a) presents objectives and informational inputs for the project. The goals of the sampling program conducted from 2014 through 2016 are summarized below.

- Determine fish tissue concentrations of DDTs and PCBs at very low concentrations to assess contaminant trends over time.

- Determine whether installation of the isolation cap will be necessary to attain the cap-related fish cleanup goals recommended in the IROD.
- Determine whether concentrations of DDTs and PCBs in fish exceed IROD fish cleanup goals.

The proposed data inputs would include the following:

- The IROD for PV Shelf presents cleanup goals to reduce the risk to human health from the consumption of WC caught in the vicinity of PV Shelf; the values are 400 ug/kg for DDTs and 70 ug/kg for PCBs (EPA, 2009). Based on previous fish testing for the EPA ICs program at PV Shelf, the desired reporting limits (RLs) for fish testing were established at less than 1 ug/kg; this would require HRGC/HRMS methods.
- The IROD identifies monitoring for DDTs and PCBs in WC as a key element of MNR at PV Shelf. The QAPP developed for fish (Gilbane, 2016a) describes how the seven EPA fish collection areas and numbers of samples were derived by consensus during the Palos Verdes Shelf Technical Information Exchange Group (PVSTIEG) scoping meeting held in January 2014. Barred sand bass (BSB) was also added as an indicator species for this study because high concentrations of DDTs and PCBs had been found in this species during previous studies (National Oceanic and Atmospheric Administration [NOAA]/EPA, 2007). Historically there has been a high catch frequency for BSB reported by boat-based anglers near PV Shelf, and, during EPA's fish tracking study previously conducted at PV Shelf, BSB demonstrated site fidelity to PV Shelf (Lowe, 2013).
- The fish tissue data set will be compared to the IROD cleanup goals and used to calculate parameters for each fish collection area. These parameters include minimum and maximum concentrations, average concentrations, and exposure point concentrations (EPCs) of DDTs and PCBs.

2.0 METHODS

This section provides a synopsis of activities, including sample collections and analyses, that were conducted during the 2013-2016 MNR sampling program.

2.1 SEDIMENT

Operations for collecting cores are described below.

2.1.1 Shelf-Wide Sample Grid

Figure 2-1 shows the locations of sediment cores planned for the 2013 shelf-wide sampling event. As described in the Field Sampling Plan (FSP; ITSI Gilbane, 2014), these locations were collocated with EPA's baseline program conducted in 2009. For both events, EPA used a subset of the Sanitation Districts' stations typically used for the JWPCP National Pollutant Discharge Elimination System (NPDES) compliance programs for sediment sampling (California Regional Water Quality Control Board, Los Angeles Region [Water Board], 2017). The Sanitation Districts have established shore-normal Transects 0 through 10, numbered north to south. Transect 0 is located north of Palos Point near Bluff Cove (Figure 1-1), and Transect 10 is located near Point Fermin at San Pedro. Transect 8 is aligned along the White Point outfalls. Along these transects, the Sanitation Districts have established stations along the following main isobaths (water depths): A (305-m); B (150-m); C (60-m); and D (30-m). For locations between main isobaths, the convention is to combine the names of the two nearest isobaths (e.g., isobath BC is at a depth of 100 m, and DC is at a depth of 40 m). For EPA's 2013 MNR shelf-wide program, primary cores were planned for 34 locations using Transects 1 through 10 and along the B, BC, C, and DC isobaths. Replicate cores were planned for locations 2B, 4C, and 5B (Figure 2-1).

2.1.2 Outfall Area Sample Grid

In addition to the shelf-wide locations, EPA planned a grid 35 of core locations for the outfall area (OA) near the Sanitation Districts' outfall diffusers (Figure 2-2). Twenty-five locations were collocated with OA cores used for EPA's 2009 sampling event (ITSI Gilbane, 2014). The locations had been selected based on historical data including: historical concentrations of COCs; erodibility of the sediment; penetration depths of sediment profile imaging (SPI) cameras from a 2004 survey (SAIC, 2005b); and the reported thickness of the EA bed.

For the 2013 sampling event, ten additional OA cores were collected to address concerns that "hot spot" areas may have been missed in 2009. Seven OA locations were selected for single replicates. The spacing between adjacent core locations ranged from approximately 0.1 km to 1.2 km. Figure 2-2 shows the OA sample grid. All core locations within the OA boundary were within 1.5 km of a diffuser section of the Sanitation Districts' four outfall pipes.

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 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.

Coring operations were conducted on the Sanitation Districts' research vessel (RV), the 20-m *Ocean Sentinel*. Ship positioning for each core drop was based both on the planned ocean depth and latitude and longitude coordinates. To navigate and position the vessel, a commercial marine navigation software product from Nobeltec, Beaverton, Oregon, was used with a differential global positioning system (DGPS). A fathometer was used to measure the ocean depth at the time of core collection. During each core drop, the vessel position was logged (i.e., a navigation fix was recorded) at the exact time that the coring device reached the ocean floor. 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 the Sanitation Districts' infrastructure during operations near the Sanitation Districts' outfalls, the ship captain used sonar to monitor the locations of the outfall pipes and supporting ballast. The captain operated the DGPS, and manually recorded in a daily navigation log all significant events and any problems encountered.

2.1.4 Coring Procedure

Sediment cores were collected in October 2013, using the Sanitation Districts' standard gravity core sampler. Figure 2-3 is a schematic of the gravity coring device used for this program. The coring device had a cutting head about 100 cm in length with an effective sampling length of about 90 cm. At the start of the operation, the core sampler was attached to a winch cable; the winch was supported by a small crane mounted on the stern of the RV. Lead weights attached to the top of the cylinder provided added driving force for penetration of the soft EA bed; for the ocean depths at PV Shelf, a top assembly was attached to the main coring device, and 9-kilogram (kg) rings were added to give a total weight of about 125 kg. The total length of the coring device with cutting head and weighted top assembly was about 135 cm.

To address concerns regarding the possibility of "blow-off" of the surface layer of the sediment bed during coring and the angle of penetration of the corer into the sediment bed, Sanitation Districts' staff modified the coring assembly to mount a digital video camera and an inclinometer (Photographs 001 and 002 in Appendix A). The camera was used for cores collected at depths of 60 m or less, except at BA4DC. At this location, three attempts to collect core were unsuccessful; the fourth attempt was made without the camera and was successful. Video also is not available for BA3DC due to an issue with the captured electronic file. The inclinometer was used for all cores.

For each core collection, a clean acetate liner was placed into the core barrel prior to each drop. 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 retrieved corer was placed on the deck, the core was inspected for acceptance or rejection. Criteria used for rejection 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).

Each accepted core was retrieved from the corer with the acetate liner intact. The liner ends were sealed with plastic bags. Strapping tape was applied in a spiral around the bag and the entire length of the core to maintain core integrity. The core length was measured (Photo 003 of Appendix A) and recorded, and the core liner was marked with indelible ink to record the core location name, core length (in cm), and sampling date. Approximately 1 liter (L) of liquid nitrogen was applied to each end of the galvanized steel (GS) sleeve to provide quick freezing, and the sleeved core was then and immediately stored vertically in one of two shipboard wooden cold boxes (Photo 004 of Appendix A). Each cold box had been previously stocked with dry ice and equipped with supports to hold nine cores. The cores were transported to JWPCP for storage in a deep freezer, sometimes daily if the cold boxes were full or near-full.

2.1.5 Core Processing

Core cutting events occurred in November and December 2013 at the Sanitation Districts' Water Quality Laboratory (WQL) at the JWPCP. Core cutting was conducted by Sanitation Districts' staff (see Photo 005 of Appendix A). Cutting techniques conformed to WQL's *Sediment Core Cutting Procedure, Method 500C* (see FSP; ITSI Gilbane, 2014); these techniques were used to create sediment slices, each with an approximate thickness of 2 cm. Cuts were made on each core until the bottom remaining material was less than 2 cm thick, and this remainder was discarded.

To generate 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 about 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; Photo 006 of Appendix A). As agreed between EPA and the Sanitation Districts, archived samples were sent to the Sanitation Districts' sediment archive for storage.

2.1.6 Testing of Sediment Samples

Sediment samples generated from the core cutting events were transported from JWPCP to GMU Geotechnical, Inc. (GMU), Rancho Santa Margarita, California, for geotechnical testing, and to Eurofins Calscience (Eurofins CS), Garden Grove, California, for testing of chemistry parameters and MC.

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 0-8 cm, were tested separately. For the portions of each core representing bed intervals at depths 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 10-12 cm). For cores with an odd number of slices, the slice remaining after two-way compositing, i.e., the deepest slice, was not used.

2.1.6.1 Geotechnical Tests

At GMU, samples were stored in a freezer until they were prepared for analysis. Sample preparation began with opening the sample containers and examining the frozen chunks. Where no compositing was required, samples were thawed and analyzed by the test methods listed below. For testing the two-way sample composites for BD_w, 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, was tested for BD_w. For the other geotechnical tests (i.e., grain size and SG), where sample compositing was required, laboratory staff removed thawed equal portions from each of the two individual sample containers and placed them into a clean glass beaker. The material then was mixed using a stainless steel spoon or spatula to create a visually homogeneous mixture. The mixture was then tested for the parameters listed below.

- For 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 (um; #200 sieve) and larger, and a hydrometer to measure the distribution of particle sizes smaller than 75 um.
- For BD_w, GMU used ASTM D7263-09: *Standard Test Method for Laboratory Determination of Density (Unit Weight) of Soil Specimens, Method A (direct measurement)*.

- For SG (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*.

2.1.6.2 Chemistry Tests

Eurofins CS tested sediment samples for MC, TOC, and COCs. Eurofins CS is certified as an environmental testing laboratory under the Environmental Laboratory Accreditation Program (ELAP) administered by the California State Water Resources Control Board (SWRCB). Gilbane selected Eurofins CS as the chemistry testing laboratory after rigorous vetting, including performance evaluation (PE) tests (see Section 4.1.1.1).

At Eurofins CS, 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 homogeneous mixture. All utensils were thoroughly cleaned between sample preps.

After compositing, a total of 1,220 samples was generated. Sample counts were as follows: 523 samples were generated for the shelf-wide primary cores; 44 samples were generated for the shelf-wide replicate cores; 541 samples were generated for the OA primary cores; and 112 samples were generated for the OA replicate cores.

Tests of the sediment samples were conducted in accordance with the requirements specified in the guidance documents listed below.

- 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 (ITSI Gilbane, 2014)

Specific analytical methods used for this project are listed below.

- TOC using EPA Method 9060, a water method modified for sediment (includes an acidification step)
- MC (in percent moisture) using Eurofins CS 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

During sediment testing in 2009, a procedural improvement for preparing DDT samples was proposed by Eurofins CS 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 of the gas chromatography/mass spectrometry (GC/MS) instrument during sample analysis. Eurofins CS 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. This same procedure was used for the 2013 sediment testing. A detailed description of this approach is provided in the *Revised Final Data Report for the Fall 2009 Sediment Sampling Program* (ITSI Gilbane, 2013b).

For the 2013 sediment program, the PCB list was expanded to include the 46 congeners used during previous EPA fish studies at PV Shelf (Innovative Technical Solutions, Inc. [ITSI], 2011). Table 2-1 lists the individual chemistry analytes (eight DDT compounds and 46 PCB congeners) used for the chemistry tests of sediment samples, with the associated RLs. Table 2-2 lists various congener lists commonly used by research institutions including NOAA and the World Health Organization (WHO) that are concerned with PCBs in the general environment. EPA’s expanded list includes all 21 congeners from NOAA’s list (NOAA, 1998), and the twelve congeners recognized by WHO as dioxin-like (WHO, 2006), in addition to other congeners of interest.

2.1.7 Geostatistical Modeling of Sediment Data

As was done for EPA’s 2009 sediment data set, Mining Visualization System (MVS) software (C Tech Development Corporation, Bellingham, Washington) was used as the geostatistical modeling platform to characterize the sediment bed. To duplicate the previous approach at PV

Shelf, 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 for sediment at PV Shelf (Sherwood et al., 2006). The model extent encompassed all core locations (Figure 2-1); the total modeled area was 29.8 km^2.

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.

The model was used to derive values for various characteristics of the sediment bed at PV Shelf, including the mean (average) OC normalized concentrations and total masses of COCs for both the entire modeled grid and for the 0-8-cm sediment layer (see Section 3.1.6). Appendix C presents a detailed discussion of the MVS modeling effort and software parameters, and provides a contextual analysis of input/output parameters and values.

2.2 WATER COLUMN SAMPLING

To directly support the MNR component, Gilbane conducted high resolution grab sampling of the water column during 2015. This was the first EPA-sponsored event to use high resolution grab sampling at PV Shelf. A round of water sampling using PSDs was also conducted in 2013. (EPA had sponsored a previous PSD sampling event at PV Shelf in 2010 [Fernandez et al., 2012]). The high resolution event and the 2013 PSD event are described below.

2.2.1 High Resolution Grab Water Sampling

2.2.1.1 High Resolution Water Sampling Grids

Figure 2-4 shows the grid for the high resolution grab samples. As described in the QAPP for high resolution sampling (Gilbane, 2014), the sample locations were generally selected to match the locations from the Sanitation Districts' standard benthic sediment sampling program (Section 2.1.1). The sampling depths in the water column were selected generally to match EPA's PSD water sampling events (Section 2.2.2). Five locations (W1 through W5) were selected at deep-water locations near the edge of the PV Shelf or past the shelf break on the continental slope. Sample location T11 is far southeast of the PV Shelf contaminated zone, on the 60-m isobath.

This location has been used during PSD events as a background reference location, and was again used during the high resolution grab sampling.

2.2.1.2 Sampling Locations, Depths, and Vessel Positioning

The latitude and longitude coordinates for each water sample location were referenced to the Greenwich Meridian and NAD 83, and were reported in degrees-decimal minutes. To navigate and position the vessel, commercial marine navigation software products (including Nobeltec on the *Ocean Sentinel*) were used with a DGPS. For each sampler deployment, an accurate digital cable length counter was used to measure sampling depths; however, due to ocean swells and drift away from the vertical, the sample depth error is estimated as ±1.5 m.

Target sampling depths at 23 locations were: 5 m below the ocean surface; mid-column; and 5 m above the ocean floor. At 17 other locations, a sample was also collected 2 m above the ocean floor. These four-tiered locations were collocated with previous PSD deployments.

2.2.1.3 Water Sampling Procedure

During the 2015 water sampling program, a grab sampler device developed by Kinnetic was used. The sampler held a 2.5-L sample bottle; this approach allowed adequate sample volume to be collected during a single “drop”. Other features of the sampler were a spring-loaded stopper and rope trip-line system; a removable base plate to allow the quick loading and release of sample bottles; and a mounted digital video camera allowing review of each drop (Photo 007 in Appendix A).

The grab sampler was attached to a winch cable supported by a small crane mounted on the stern of the vessel (Photo 008 in Appendix A). Detachable lead weights hanging below the sampler provided counter-weight for the buoyancy of the empty sample bottle, and resistance to trip the stopper against the spring closing mechanism. The maximum counterweight for the deepest (200-m) samples was approximately 136 kg. The total length of the grab sampler was about 1.5 m.

A clean 2.5-L amber sample bottle was placed into the sampler prior to each deployment. The bottle cap was removed and stored in a clean plastic bag during the sampler deployment. To initiate a sampling deployment, the vessel was piloted to the selected sample location using the

DGPS. The crew then used a high-speed winch to lower the sampler into the ocean. As the sampler was lowered through the water column, the spring-loaded stopper remained closed. When the sampler reached the selected water depth, the stopper trip rope was pulled and upward pressure maintained for approximately 30 seconds for the bottle to fill. When the crewman released the trip rope, the stopper closed, and the winch was reversed to pull the sampler to the surface.

After the grab sampler was retrieved and placed on the deck of the vessel, the sample bottle was inspected for acceptance or rejection. Criteria used in evaluating whether water samples should be rejected (and the sample re-collected) included:

- Visible sediment in the sample bottle, indicating that the sampler had contacted the ocean floor and stirred up the sediment (this criterion was adopted because visible sediment could interfere with the sample filtering efficiency at the laboratory); and
- The O-ring on the bottle stopper entering the sample bottle (for initial drops conducted during the pilot test, silicone O-rings were found in several deep samples due to the tremendous pressure of the initial water flow into the bottle – the O-ring/stopper was re-designed).

The digital video of each sampling deployment was reviewed to ensure that the trip line had not snagged and opened the sample stopper prematurely; to assess possible sediment disturbance (for the deepest samples); and to assess tidal drift during sampling. Each acceptable water sample bottle was released from the sampler, some water was poured out of the bottle, and the original bottle cap was hand tightened to seal the sample. The bottle was dried with a paper towel, and a pre-printed sample label with the sample identification, date, and sample time added in indelible ink, was affixed to each bottle.

Use of this sampler greatly reduced the need for equipment decontamination between samples, because the only reusable components in contact with the sample water were the bottle stoppers. Six stoppers were used throughout the project and they were decontaminated in batches using a soapy water wash; several deionized water rinses; a laboratory-grade acetone wash; and a final rinse using high-purity reverse osmosis (RO) water from the testing laboratory (Photo 009 in Appendix A). Periodically, a final rinsate sample was collected for chemical testing. The clean (decontaminated) bottle stoppers were stored in a clean, sealed plastic bag until deployment.

Each sample and rinsate bottle was wrapped in bubble wrap and stored upright in a large marine cooler on a bed of ice and within a heavy garbage bag that was later sealed to contain melt water. All sample coolers were shipped overnight to ALS Life Sciences (ALS), Burlington, Ontario, Canada, the testing laboratory (Photo 010 in Appendix A).

2.2.1.4 Sample Preservation, Filtration, and Extraction

Water samples collected during each sampling event were transported to ALS in Canada. This required ALS to send a cross-border courier to a FedEx depot in Cheektowaga, New York, to receive shipments and accept samples. ALS is accredited in California under the ELAP administered by SWRCB, and in Canada by the Canadian Association for Laboratory Accreditation.

All samples were stored by ALS in a refrigerator at less than 6 degrees Celsius (^{o}C). Samples were filtered prior to extraction to isolate dissolved-phase DDTs and PCBs in the water samples. All glassware and filters were cleaned appropriately for ultra-trace analyses. High purity RO water generated by ALS was used for the field equipment blanks and for all laboratory blanks and quality control (QC) samples.

Samples were filtered gravimetrically through glass-fiber filters with a nominal pore size of 0.7 um. The resulting filtrate was defined as the dissolved fraction, in accordance with a previous study (Zeng, 1999). During filtration and storage awaiting extraction, the funnels and flasks were covered with aluminum foil to avoid possible sample contamination by dust. The sample bottle was not solvent- or water-rinsed, to minimize re-mobilization of particulates through the filter, and to reduce filtering times. Because of possible losses of dissolved targets during the filtration process, all spiking of samples was done after filtration. This included native target spiking for laboratory control samples (LCSs) and the spiking of carbon isotope 13 (C-13)-labeled extraction standards during extraction.

Sample extractions were performed on the same work shift as the filtrations. The extractions were performed using 2-L separatory funnels. Transfer occurred in approximately two-thirds and one-third aliquots, using the appropriate volumes of dichloromethane extract, with each extraction repeated three times. The combined extracts were collected in a single 500-milliliter (mL) flask. The raw sample extract was then split in half for DDTs and PCBs analysis, and spiked with the appropriate C-13-labeled cleanup standards.

The DDT portion of the extract was first cleaned by gel-permeation chromatography (GPC) to help remove intractable biological interferences and improve performance of the gas chromatography (GC), and then by silica column chromatography (activated silica gel), a cleanup designed to remove earlier eluting hydrocarbon/organic fractions. The PCB portion of the extract was cleaned by acidified silica column chromatography, followed by activated alumina column cleanup.

2.2.1.5 Testing of High Resolution Grab Water Samples

ALS tested the water samples in accordance with the requirements specified in the documents listed below.

- EPA Method 1668C: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS, EPA-820-R-10-005 (EPA, 2010)
- EPA Method 1699: Pesticides in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS, EPA-821-R-08-001 (EPA, 2007)
- Final Quality Assurance Project Plan - Water Sampling Program, Remedial Action – Monitored Natural Recovery Component, Palos Verdes Shelf, Los Angeles County, California (QAPP; Gilbane, 2014)

The specific analytical methods used for water testing are listed below.

- Organo-chlorine pesticides (OCPs/DDTs) by HRGC/HRMS, EPA Method 1699
- PCBs by HRGC/HRMS, EPA Method 1668C

Table 2-3 lists the individual chemistry analytes, including eight DDT compounds and 46 PCB congeners, along with the associated RLs used for the chemistry tests. For the uncommon analytes DDMU and DDNU, ALS performed method detection limit (MDL) studies and surrogate recovery limit studies.

2.2.2 PSD Water Sampling

The PSD collection program was set forth in the PSD QAPP (Fluen Point Environmental, 2013). Appendix D includes the complete report of the results. Salient details of the PSD sampling program are described below.

2.2.2.1 PSD Water Sampling Grid, Locations, and Depths

Figure 2-4 shows the sample grid for the 2013 PSD event. PEDs were deployed at 16 stations on the PV Shelf and at one background station T11. SPMEs were co-deployed with PEDs on the same mooring lines at five stations on the PV Shelf (4C, 7C, 8C, 9C, W3) and at the background station T11. As in the 2010 sampling program, samplers were deployed at three depths at each station: 5 m below the surface (near-surface); mid-column; and 5 m above the sediment-water interface (near-bottom). Discrete water samples were collected at depth using a Niskin bottle, and DOC readings were measured with a field meter.

2.2.2.2 PSD Water Sampling Procedures

PE samplers were prepared by impregnating them with the following performance reference compounds (PRCs): ^{13}C-4,4'-DDT, ^{13}C-4,4'-DDE, ^{13}C-4,4'-DDD, ^{13}C-PCB28, ^{13}C-PCB52, ^{13}C-PCB118, and ^{13}C-PCB128. For the PEDs, this step was accomplished by soaking each sampler in an aqueous solution of the PRCs in a 1-L amber glass jar for at least 20 weeks before deployment. SPME samplers were also fortified with PRCs: ^{13}C-4,4'-DDE, PCB 50, ^{13}C-PCB 52, PCB 98, ^{13}C-PCB 128, PCB 155, and PCB 184. The pre-cleaned SPME samplers were immersed in the PRC solution for 4 hours in a dark temperature-controlled room after which they were dried and stored at -20^{o} C until use. After preparation, both types of samplers were deployed in triplicate at each station/depth. Water temperature and conductivity were measured using conductivity-temperature-depth meter casts at the time of retrieval. The problem of PED loss during deployment, encountered during the 2010 sampling event was addressed by using stainless steel wire for threading of sampler polymer to the deployment gear, although some losses of samplers still occurred (as further discussed in Appendix D).

2.2.2.3 PSD Sample Preservation and Extraction

All retrieved PSDs (PEDs and SPMEs) were transported on ice to the analytical laboratory at the Southern California Coastal Water Research Project (SCCWRP) facility in Costa Mesa, California, for analysis. SCCWRP's ongoing mission is to provide a scientific foundation for managing marine and coastal resources in Southern California. As part of that mission, SCCWRP organizes and participates in collaborative regional monitoring programs, such as the Southern California Bight Regional Monitoring Program. Samplers were frozen at the laboratory until analysis.

Prior to extraction, the PEDs were wiped to remove adhering particles and biofilms, and cut into small pieces. The PEDs were then spiked with recovery surrogates and extracted three times by sonicating in methylene chloride. The solvent was concentrated to a small volume and exchanged to hexane, at which point internal standards were added in preparation for analysis. SPME fibers required no extraction, but were manually injected on the instrument for analysis.

2.2.2.4 Testing of PSD Samples

The SCCWRP laboratory tested the water samples using gas chromatography/mass spectrometry in selective ion mode in accordance with the requirements specified in the PSD QAPP (Fluen Point, 2013). The specific analytical methods used for water testing are listed below.

- SCCWRP SOP Chapter 24 – Determination of DOC and Total Nitrogen (TN) in Water Samples
- SCCWRP SOP Chapter 27 – Construction, Deployment, Retrieval, and Analysis of SPME Samplers
- SCCWRP SOP Chapter 35 – Use of Polyethylene Devices (PEDs)

Table 2-4 lists the individual analytes along with the associated RLs used for the chemistry tests performed on the PSDs at SCCWRP's analytical laboratory.

2.3 FISH

The fish collection program was set forth in the fish QAPP (Gilbane, 2016a). Salient details on the fish sampling program are described below.

2.3.1 Design of Sample Collection

The MNR fish collection areas and numbers of samples were derived by consensus during a scoping discussion at the PVSTIEG meeting held January 2014. Seven collection areas were selected, each 1 km x 5 km. They are as follows (from north to south): Ventura Flats; Redondo Flats; three areas within the Sanitation Districts' NPDES bioaccumulation zones (EPA Zones 1, 2, and 3); an area near the breakwater of Los Angeles Harbor; and Huntington Flats (Figure 2-5). These areas are described as follows:

- Ventura Flats is situated approximately 110 km northwest of the Sanitation Districts' outfall diffusers; it is the collection area farthest from the diffusers and serves as a reference area for assessing spatial variability of contaminants in WC.
- Redondo Flats is located north of the Palos Verdes Peninsula and the deep ocean Redondo Canyon, which is regarded as an impediment to fish migration along the coast;

it is about 25 (shoreline) km north of the Sanitation Districts' outfalls. BSB and WC collections were planned for this area. The resulting analytical data would be used to assess the spatial variability of contaminants in both species in the northward direction from the outfalls.

- EPA Zones 1, 2, and 3 are subareas within the respective boundaries of the Sanitation Districts' three Fish Tissue Bioaccumulation Sampling Zones used in the JWPCP NPDES compliance programs for fish. The EPA zones were located along the 60-m isobath, where the Sanitation Districts' outfall diffusers, the former source of release of COCs to the environment, are located. BSB and WC collections were planned for each of these three EPA zones.
- The Breakwater collection area is located on the ocean side of the breakwater at Los Angeles Harbor and is approximately 10 km east of the Sanitation Districts' outfall diffusers. BSB and WC collections were planned for this area. Analytical data for fish caught at the breakwater would be used in assessing spatial variability of contaminants in both species.
- Huntington Flats is located approximately 25 km east-southeast of the Sanitation Districts' outfalls and is a known spawning area for BSB. Analytical data for BSB caught in this area are of interest to study spatial variability of contaminants in the fish and the possible effects of cyclic loading on spawning fish.

Other features of the collection areas are indicated on Figure 2-5 and described below.

- The Zone 1 and Zone 2 collection areas are within the commercial catch ban area for WC established by CDFW (CDFW, 1990).
- The Zone 3, Breakwater, and Redondo Flats collection areas are within the "red zone" published in guidelines from the Office of Environmental Health Hazard Assessment (OEHHA) of the California Environmental Protection Agency (CalEPA); the public is advised to not consume BSB or WC caught in this zone (CalEPA/OEHHA, 2009).
- The Huntington Flats collection area is within CalEPA/OEHHA's "yellow zone"; the public is advised to limit consumption of BSB and WC caught in this zone (CalEPA/OEHHA, 2009).
- The Ventura Flats collection area is outside CDFW's WC catch ban area and CalEPA's fish advisory zones.

Table 2-5 presents the number of fish planned for each area. As indicated, the number of specimens generally planned for each fish species for each collection area was 30. This value is generally accepted as a sample population that provides a statistically supportable representation of the distribution of contamination in the populations of fish sampled (NOAA/EPA, 2007). The number of BSB specimens planned for the Zone 2 collection area was limited to 10 by the JWPCP NPDES permit. For Ventura Flats, collections of only WC were planned. For

Huntington Flats, collections of only BSB were planned, as that area is a known BSB spawning ground.

2.3.2 Fish Collections, Handling, and Testing

Collection methods included hook and line, spear fishing, traps, and trawls (Photos 011 and 012 in Appendix A). Caught fish were weighed and measured for standard length and total length (Figure 2-6, Photos 013 and 014 in Appendix A). BSB specimens kept for analysis met the minimum size limit (total length of 14 inches) as specified in the saltwater sport fishing regulations set by CDFW (CDFW, 2017). There are no CDFW size limits for WC.

Specimens retained for analysis were wrapped in aluminum foil, labeled, and sealed in a plastic bag for storage (Photo 015 in Appendix A). Most fish specimens were frozen onboard the respective fishing vessel, then transferred to the freezer (-20^{o} C) at the Sanitation Districts' Marine Biology laboratory in Carson, California (Photo 016 in Appendix A). Some fish collected by Seaventures in 2016 were immediately shipped on wet ice to the testing laboratory.

Prior to fish collection, Gilbane had conducted a laboratory selection effort by having candidate labs analyze a standard reference material (SRM) fish tissue sample (SRM 1946 – Lake Superior homogenate) obtained from the National Institute of Standards and Technology (NIST). Gilbane selected Vista Analytical Laboratory, Inc. (Vista), El Dorado Hills, California, as the chemical testing laboratory for the fish sampling program. Vista is accredited in California under the ELAP administered by SWRCB.

To initiate fish testing, the whole fish specimen was removed from the storage freezer and placed under a fume hood to thaw at ambient temperature. For BSB specimens, a single filet was cut and the skin was then removed. Most of the WC specimens were small and required two skin-off filets to achieve a minimum sample mass of 20 g. Each filet was cut into dorsal/ventral strips about 2 cm in width, then shuffled prior to being run through a grinder, to provide homogenization. Between samples, all grinding parts and components were thoroughly cleaned with soap and water; multiple solvent rinses; and a final organic-free water rinse.

Each homogenized sample was placed in a beaker and mixed with sodium sulfate solution to remove moisture, and stirred frequently to remove lumps. After one hour, an appropriate volume of internal standard (IS) solution and LCS were added. The mixture was then extracted for 18 to 24 hours with a solvent solution of methylene chloride and hexane. The extract was concentrated and prepared for acid-base silica gel (ABSG) cleanup. All traces of solvent chemicals other than hexane were removed from the extract. The sample extract was transferred to an ABSG column with hexane, and the eluate was collected and concentrated for analysis for DDTs and PCBs. A small portion of the initial sample homogenate was extracted separately for lipids analysis using a chloroform-methanol solvent. The extracts were analyzed in accordance with the guidance documents listed below.

- EPA Method 1699: Pesticides in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS. EPA-821-R-08-001 (EPA, 2007)
- EPA Method 1668C: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS. EPA-820-R-10-005 (EPA, 2010)
- A Rapid Method of Total Lipid Extraction and Purification (Bligh-Dyer, 1959)

The specific analytical methods used for fish tissue analyses are listed below.

- Organo-chlorine pesticides (OCPs) by HRGC/HRMS, EPA Method 1699, using a ZB-50 GC column
- PCBs by HRGC/HRMS, EPA Method 1668C, using a ZB-1 GC column
- Total extractable percent lipids (Lipids) by Bligh-Dyer extraction

Table 2-6 lists the individual chemistry analytes with the associated RLs.

2.4 DATA MANAGEMENT SYSTEM

A web-based environmental data management system (eDMS) developed by Synectics, Sacramento, California, was used to manage the data received from all testing labs, including the geotechnical (sediment) and chemistry (sediment, water, and fish tissue) laboratories. The eDMS provided access to the chemistry data for the data validation step (Section 2.5) and, combined with Access software, allowed for the efficient transfer and tabulation of data.

2.5 DATA VALIDATION

The analytical data sets for sediment, water, and fish were reviewed and validated by Veridian Environmental, Inc. (Veridian), Davis, California, following procedures specified in the respective QAPPs (Gilbane, 2013a, 2014, 2016a). For sediment and fish tissue, approximately 10% of the data was subjected to full data validation, and 90% of the data was subjected to routine data validation. For the water data set, full validation was performed on approximately 23% of the data, and 77% received routine validation. Veridian used an automated data validation system augmented by manual review of all project data. Results from the data validation procedures are discussed in Section 4.0.

3.0 RESULTS

This section presents the results of the MNR sampling program, including collection of sediment cores, generation of sediment samples, collection of water samples, collection of fish, and results of laboratory tests on samples of sediment, water, and fish tissue.

3.1 SEDIMENT

3.1.1 Core Retrieval

Daily cruises for core collection were conducted on October 15-17, 21-23, and 28-29, 2013. Appendix E includes cruise notes and video recordings of the coring drops. Primary and replicate cores were collected as planned (Sections 2.1.1 and 2.1.2). Horizontal accuracy was +/- 3 m, and the actual sediment core locations were within 30 m of target locations. The coring crew experienced one bad weather day (heavy winds, high seas) on October 28, 2013; otherwise, core retrieval operations went as planned.

Core retrieval was difficult at location BA10C on the 70-m isobath, where three drops of the coring device resulted in lack of recovery (likely due to rocky substrate); one drop of the coring device resulted in the liner coming off; and a satisfactory core 25 cm in length was retrieved on the fifth drop. At BA2B on the 150-m isobath and BA2DC on the 40-m isobath, two drops were required to obtain a satisfactory core. At BA3DC on the 30-m isobath, three drops were made to obtain a satisfactory core. At OA24 on the 70-m isobath, five drops were made to obtain a usable core. At several locations, damage to the coring device or the liners in the coring device occurred during the operation, requiring additional drops. For the eight days of core collection, the daily coring success rates (defined as the number of usable retrieved cores divided by the number of drops) were 86, 94, 63, 48, 47, 73, 100, and 75%. Tables 3-1 and 3-2 present coordinates of the cores collected for the shelf-wide area and OA, respectively.

Table 3-3 presents the lengths of the sediment cores collected. The maximum core length was 86 cm at location BA4DC (offshore of Portuguese Bend). Other cores with lengths of 80 cm or more were retrieved at location BA5DC (also offshore of Portuguese Bend), and at locations OA05, OA08, and OA11 (near the Sanitation Districts' outfall diffusers). The overall average length of successfully retrieved cores was approximately 53 cm. Average core lengths along individual isobaths were as follows: 56 cm for the 40-m isobath; 70 cm for the 60-m isobath; 32

cm for the 100-m isobath; and 50 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 1.5:1 (BA2B) to 1:0.8 (OA16).

3.1.2 Generation of Sediment Samples

Cores were cut into slices at JWPCP during two separate events, one event occurring from November 18-22, 2013, and another event conducted from December 9-11, 2013. Core cutting was conducted by Sanitation Districts' staff at the WQL at JWPCP. Each slice had an approximate thickness of 2 cm. Cuts were made until the bottom remaining material was less than 2 cm in thickness, and any remainder was discarded. A total of 2,084 sediment slices was generated from the sediment cores collected during the 2013 sampling event.

3.1.3 Results of Physical Tests – Sediment

As described previously, GMU composited sediment samples before conducting physical tests. A total of 1,215 samples was generated. Sample counts were as follows: 516 samples were generated for the shelf-wide cores; 44 samples were generated for the shelf-wide replicate cores; 540 samples were generated for the OA cores; and 111 samples were generated for the OA replicate cores.

3.1.3.1 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 3-4 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. Summary tables of grain size test results for shelf-wide and OA samples are provided in Appendices F and G, respectively.

3.1.3.2 Bulk Density, Moisture Content, and Specific Gravity

Appendices H and I present tables showing values of BD_w and SG (as reported from the geotechnical laboratory) and MC values (as reported from the chemistry laboratory) for the shelf-wide and OA samples, respectively. The SG 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 BD_d, calculated as follows:

$$BD_d = \frac{BD_w}{1+W}$$

where:

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

Ranges of values in single samples were as follows:

- MC values ranged from about 16% in core BA6B (located on the 150-m isobath, in the 44-48-cm bed-depth interval), to about 78% in core BA4B (on the 150-m isobath, in the 8-12-cm interval).
- BD_d values ranged from 0.62 g/cm3 in core BA8C (located on the 70-m isobath near the Sanitation Districts' outfall diffusers, in the 16-20-cm bed-depth interval), to 1.6 g/cm3 in core BA6B (on the 150-m isobath, in the 44-48-cm bed-depth interval).
- SG values ranged from 2.05 in core BA8C (located on the 60-m isobath, in the 20-24-cm bed-depth interval), to 2.86 in core OA18 (on the 90-m isobath, in the 2-4-cm bed-depth interval).

For the 0-8-cm interval, average values over all cores were 39% for MC, 1.06 g/cm^3 for BD_d, and 2.68 for SG. For the core intervals below 8 cm, the average values were 37% for MC, 1.14 g/cm^3 for BD_d, and 2.66 for SG. MC testing was not possible for BA10C for the 0-2-cm interval due to insufficient sample volume; thus, the BD_d value was not calculated for this sample.

3.1.4 Results of Chemistry Tests – Sediment

Appendices J and K present test results for TOC and DDT analyses of samples derived from the shelf-wide and OA cores, respectively. Appendices L and M present the results for PCB tests for the shelf-wide and OA samples, respectively. Appendix N includes the complete reports from the analytical laboratory.

3.1.4.1 Total Organic Carbon

Reported values of TOC for single samples ranged from 0.54% in core BA10C (located on the 60-m isobath southeast of the Sanitation Districts' diffusers, in the 16-20-cm bed depth interval), to 19% in core BA8C (on the 60-m isobath, in the 16-20-cm interval). Table 3-4 lists the TOC values for cores collected along the 60-m isobath. Values generally were higher for cores northwest of the Sanitation Districts' outfalls than for cores southeast of the outfalls.

Coefficients of determination (R^2) were calculated using Microsoft Excel for TOC concentrations versus concentrations of Total DDT Compounds, and TOC concentrations versus Total PCBs (expanded list). The results showed good (albeit non-linear) correlations with concentrations of Total DDT Compounds ($R^2 = 0.73$) and with Total PCBs ($R^2 = 0.79$). (An R^2 value of 1.00 indicates a strong correlation; a value of 0 indicates no correlation.) Appendix O includes graphic representations of these correlations.

3.1.4.2 DDTs in Sediment

Results of individual DDT analytes were organized into the two DDT groupings (summations) listed below (see Appendices J and K).

- Total DDTs is the summation of the o,p'- and p,p'- isomers of DDD, DDE, and DDT.
- Total DDT Compounds is the summation of Total DDTs plus p,p'-DDMU and p,p'-DDNU.

One DDT form was detected in at least one sample from every core, and at least one DDT form was detected in every sample from 36 out of 37 shelf-wide cores and in all 35 OA cores. Values of Total DDT Compounds for a single sample ranged from 1.1 ug/kg in core BA5BR (located on the 150-m isobath, in the 56-60-cm bed-depth interval) to 350,000 ug/kg in core BA8C (on the 60-m isobath, in the 16-20 cm interval). The most prevalent DDT compounds – both in terms of the number of detections and the magnitude of concentrations – were p,p'-DDE and p,p'-DDMU. For the entire sediment data set, concentrations of p,p'-DDE showed moderate correlation with concentrations of p,p'-DDMU ($R^2 = 0.65$; see Appendix O). The parent compound DDT was reported only at low relative concentrations. Table 3-5 shows average concentrations of the DDT groupings in the 0-8-cm bed-depth interval of each core. Figure 3-1 is an interpretive rendering of these average concentrations of Total DDTs in the 0-8-cm bed-depth interval. Figure 3-2 shows an exaggerated vertical profile of interpretive DDTs along the 60-m isobath, where the diffuser portions of the 90-inch and 120-inch outfalls (the outfalls that Sanitation Districts typically operates) are located, and where contaminant concentrations in sediment are highest.

3.1.4.3 PCBs in Sediment

Results for individual PCB congeners were summarized into two groups: Total PCBs – short list (the congener list previously used for the 2009 sediment data set), and Total PCBs – expanded list (see Appendices L and M). At least one PCB congener was detected in at least one sample from every core collected. Reported detections of Total PCBs in single samples ranged from 0.14 ug/kg in core BA5B (located on the 150-m isobath, in the 52-56-cm bed-depth interval) to 17,000 ug/kg in core BA8C (on the 60-m isobath, in the 32-36-cm interval). PCBs were not detected at the deepest intervals in the 23 cores with at least one sample interval with no detections; for the other 44 cores, PCBs were detected in samples generated from every bed-depth interval in the core. Table 3-6 shows average concentrations of Total PCBs in the 0-8-cm bed-depth interval of each core. Figure 3-3 shows interpretive concentration contours of the average concentrations of Total PCBs (short list) for the 0-8-cm interval without OC-normalization. The bottom half of Figure 3-4 shows a cross section of the sediment bed showing Total PCBs (short list) along the 60-m isobaths for the 2013 data set, again without OC normalization. Figures 3-5 and 3-6 are corresponding figures using the expanded list of Total PCBs.

3.1.5 OC Normalization of DDTs and PCBs

EPA's interim remedy in the IROD is based on contaminant concentrations in sediment after normalization for OC (EPA, 2009b). 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). For these reasons, similar to the 2009 sediment data processing, calculations were performed on the 2013 sediment laboratory data to provide normalization for OC, 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:

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

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

Table 3-5 shows the OC normalized average concentrations of the DDT groupings in the 0-8-cm bed-depth interval of each core. Table 3-6 shows normalized concentration of PCBs.

3.1.6 Results of Geostatistical Modeling – Sediment Data

All chemical results were entered into ARC-GIS and MVS software. The software packages were used to generate concentration contour plots and to calculate characteristics of the EA sediment bed, including mass of COCs. The computational approach used by the MVS model is described below.

- In the model input, the value for the horizontal-to-vertical (H:V) anisotropy was set to 20,000.
- The 2013 sediment data set was used to extrapolate values of BD_d 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 BD_d value by the COC concentration. Eight DDT analytes were calculated individually; the PCB congeners were grouped into a summation (Total PCBs) and then multiplied by the BD_d.
- 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 mass.

Table 3-7 lists the average values of contaminants across the EA bed, and includes estimates in the 0-8-cm bed-depth interval. Table 3-8 lists the estimates of contaminant mass. As previously mentioned, a report with full details of the MVS modeling effort and output is included in Appendix C.

3.2 WATER RESULTS

3.2.1 Grab Sampling Events

Grab samples of the water column were collected during three field deployments in 2015. In developing an optimal approach for collecting water samples at depth, a pilot test was conducted in March 2015 by staff from Kinnetic Laboratories, Inc., Carlsbad, California, and the Sanitation Districts' *Ocean Sentinel*. The pilot test assessed the feasibility of collecting a water sample directly into a 2.5-L sample bottle. Several samples were successfully collected during this cruise. A second sampling cruise was conducted from September 15 through September 25, 2015. A third cruise on November 30, 2015, was conducted using Kinnetic's 10-m RV *D.W. Hood*. This cruise was successful in re-collecting sample BA6DC-WO20-1115-1 (the original sample bottle had been broken during transport).

Sixty-nine primary water samples were collected from three depths at 23 sampling locations, and 68 water samples were also collected from four depths at 17 sampling locations where PSD samples had been collected previously. A total of 137 primary samples, 11 field replicates, and three equipment rinsate samples was collected and submitted to ALS for high resolution analyses.

During each sampler deployment, the boat propellers were stopped for variable amounts of time depending on the location and position of the wire cable and sampler trip rope, to avoid tangling the sampling gear. Without propulsion, the boats may have drifted, leading to possible positioning variances estimated to be as much as two boat lengths (i.e., 40 m for the Sanitation Districts' *Ocean Sentinel*, and 20 m for Kinnetic's *D.W. Hood*). Table 3-9 summarizes the grab sample collection data. Appendix P contains cruise notes and field notes. Videos of the sample collection are also included.

3.2.2 DDTs in the Water Column

Appendix Q presents tables of DDT test results organized by grid transect. Detected results for DDT analytes in water were reported by the testing laboratory in ng/L using three significant figures. As was done for sediment data, results for individual DDT analytes were organized into summations of Total DDTs and Total DDT Compounds. Non-detects were assigned values of zero in calculating the summations. The summations are included in Appendix Q.

Figures 3-6 and 3-7 present concentrations of p,p'-DDE for the water column at each sample location for the western and eastern sectors of the sampling area, respectively. Contaminant concentrations are shown in relation to vertical distance in the water column above the ocean bottom for each sample. Figures 3-8 and 3-9 show concentrations of Total DDTs in the same manner. Tables 3-10, 3-11, and 3-12 show results for Total DDT Compounds (all DDT forms combined) along the 150-m, 60-m, and 40-m isobaths, respectively; sample locations were grouped by distance relative to the Sanitation Districts' outfall diffusers.

A DDT isomer was detected in at least one sample collected at each location. All eight DDT isomers were reported in one sample (BA5DC-WO38-0915-1, a mid-column sample down-current of the outfall diffusers). The DDT compound most frequently detected was p,p'-DDE, and in the clear majority of samples, this compound and p,p'-DDMU were detected at concentrations far exceeding all other DDT forms. The water data set showed fairly strong correlation between concentrations of p,p'-DDE and p,p'-DDMU ($R^2 = 0.82$; see Appendix O).

The highest concentrations were found in BA4C-WO58-0915-1 (a near-bottom sample down-current [northwest] from the outfall diffusers), with maximum p,p'-DDE and p,p'-DDMU concentrations reported at 1.14 ng/L and 1.48 ng/L, respectively; the corresponding values for Total DDTs and Total DDT Compounds were 1.59 ng/L and 3.26 ng/L. The forms o,p'- and p,p'-DDT were rarely detected in any sample. For the T11 reference location (up-current [southeast] of the outfall diffusers), p,p'-DDE was reported at 0.0308 ng/L in sample T11-WO30-0915-1 (collection depth at 30 m); no other DDT forms were detected in any samples collected at T11.

3.2.3 PCBs in the Water Column

Appendix R presents tables of PCB test results organized by the shore-normal transects. Detected results for PCBs in water were reported by the testing laboratory in picograms per liter (pg/L) using three significant figures. Results for individual PCB congeners were added into summations of Total PCBs, with non-detects assigned a value of zero. The summations are shown in Appendix R.

Figures 3-10 and 3-11 present concentrations of Total PCBs for the water column at each sample location for the western and eastern sectors of the sampling area, respectively. Contaminant concentrations are shown in relation to vertical distance in the water column from the ocean floor for each sample. Tables 3-13, 3-14, and 3-15 show results for Total PCBs along the 150-m, 60-m, and 40-m isobaths, respectively; the nodes were grouped by distance relative to the Sanitation Districts' outfall diffusers.

At least two PCB congeners were detected in every water sample, and all 46 congeners were detected at least once. The maximum value of Total PCBs was 190 pg/L in sample BA7C-WO30-0315-1 (a mid-column sample in the vicinity of the outfall diffusers). Another relatively high result for Total PCBs (170 pg/L) was detected in sample BA4C-WO58 (a near-bottom sample down-current of the outfall diffusers). The minimum value for Total PCBs was 0.33 pg/L in mid-column sample BA10B-WO75-0915-1, collected at a depth of 75 m; the 5-m sample at the same location (BA10B-WO5-0915-1) had a Total PCBs result of 0.35 pg/L. Location BA10 is up-current of the outfall diffusers.

The maximum concentration for a PCB target analyte was 26.2 pg/L for PCB 8. The twelve dioxin-like PCB congeners were detected infrequently. Of these twelve congeners, PCB 126 was detected in three samples, all from location BA7C, in the vicinity of the outfall diffusers. The highest concentration of PCB 126 (1.16 pg/L) was detected in near-bottom sample BA7C-WO55-0315-1. The result for PCB 209 (5.23 pg/L), reported in the mid-column sample collected at reference location T11, is an anomalously high result; it was exceeded only by the result for a near-bottom sample collected at location BA7C at 91 m (5.36 pg/L). The few other low-level detections of PCB congeners in samples collected at T11 appear representative of background ocean water conditions.

3.3 FISH RESULTS

3.3.1 Collections and Laboratory Analysis

Fish collections took place between June 2014 and August 2016. Fish were caught by Sanitation Districts' staff from their RV *Ocean Sentinel*, and by Seaventures Inc., staff on their vessel *Early Bird II*. Collection methods included hook and line, spear fishing, traps, and trawls. Coordinates for each fish caught, with catch date and time, are presented in Table 3-16. Appendix T includes cruise reports and records of fish collections. Fish weight, standard fish length, and total fish length are also indicated.

Fish specimens were transported under chain-of-custody protocol to Vista for testing of chemistry parameters. Vista stored all fish specimens in a freezer at -20^{o} C prior to sample processing. Vista prepared 301 primary fish tissue samples (skin-off filets) and 16 replicate samples. These were analyzed for COCs using HRGC/HRMS methods, and for lipids using the Bligh-Dyer method.

3.3.2 DDTs in Fish Tissue

Appendix U presents tables of DDT test results organized by fish collection area. Detected results for DDT analytes in fish tissue were reported by the testing laboratory in picograms per gram (pg/g) using three significant figures. Results of individual DDT analytes were organized into summations of Total DDTs and Total DDT Compounds. Non-detects were assigned values of the sample-specific estimated detection limit (EDL) in calculating the summations. This approach is consistent with EPA's ICs program at PV Shelf.

Tables 3-17 and 3-18 show the calculated values for Total DDTs and Total DDT Compounds, respectively, in fish samples, in units of ug/kg (parts per billion [ppb]). Values are given by collection area and for each fish species. Figure 3-12 shows maxima, minima, and average values of Total DDTs by collection area.

3.3.2.1 DDTs in Barred Sand Bass

All eight DDT forms were detected in BSB fish tissue, but o,p'-DDT (11 of 143 samples) and o,p'-DDD (three of 143 samples) were rarely detected (Appendix U). Total DDT results (Table 3-17) show that both the maximum value for a single BSB (701,000 pg/g in sample Z1BSB-2014-28) and the highest average (mean) value for any collection area were reported for samples of fish caught at Zone 1 (near the Sanitation Districts' outfall diffusers). For the BSB data set, p,p'-DDE, o,p'-DDE, and p,p'-DDMU were detected in all samples, and the highest results were for p,p'-DDE and p,p'-DDMU. The BSB data set also showed strong correlation between detected pair concentrations of p,p'-DDE and p,p'-DDMU (R^2 = 0.84; see Appendix O). The minimum value of Total DDTs in a BSB sample was 8,770 pg/g in sample RFBSB-2016-09 from Redondo Flats. When examining Total DDTs and Total DDT Compounds in BSB by collection area (Table 3-17 and Table 3-18, respectively), Zone 1 had the highest maximum and average values.

3.3.2.2 DDTs in White Croaker

All eight DDT forms were detected in WC fish tissue, but o,p'-DDT was rarely detected (4 of 158 samples; Appendix U). The DDT isomers p,p'-DDE, o,p'-DDE, and p,p'-DDD were detected in all samples from all collection areas including Ventura Flats, the reference area for WC. The isomer p,p'-DDT was detected in at least one fish from each collection area. All concentrations of individual DDT forms above 1,000,000 pg/g were for p,p'-DDE (maxima of 2,010,000 pg/g in sample Z1WC-2014-19 [from Zone 1] and 1,860,000 pg/g in sample Z2WC-2014-15 [from Zone 2]). For the WC data set, p,p'-DDE and o,p'-DDE were detected in all samples; p,p'-DDMU was detected in all samples except for 10 fish from the Ventura Flats reference area; and the highest results were for p,p'-DDE and p,p'-DDMU. Similar to that of BSB, the WC data set showed strong correlation between p,p'-DDE and p,p'-DDMU ($R^2 = 0.84$; see Appendix O). The maximum value of Total DDTs in a WC sample was 2,360,000 pg/g in sample Z1WC-2014-19 from Zone 1. The minimum Total DDTs result was 4,490 pg/g in sample VFWC-2015-19 from Ventura Flats. When examining Total DDTs by collection area (Table 3-17), Zone 1 and Zone 2 were nearly identical for maximum and average concentrations. When examining Total DDT Compounds (Table 3-18), Zone 1 had the greatest maximum value for a single sample; Zone 1 and Zone 2 had nearly identical average values.

3.3.3 PCBs in Fish Tissue

Appendix V presents tables of PCB test results organized by fish collection area. Detected results for PCB congeners in fish tissue were reported by the testing laboratory in pg/g using three significant figures. Results of individual PCB congeners were added into summations of Total PCBs, and consistent with EPA's ICs program, non-detects were assigned values of the sample-specific EDL. Table 3-19 shows the calculated values for Total PCBs in fish samples, expressed in units of ug/kg, for ease of comparison to IROD cleanup goals. Values are given by collection area and for each fish species. Figure 3-12 shows maxima, minima, and average values of Total PCBs by collection area.

3.3.3.1 PCBs in Barred Sand Bass

All 46 target PCB congeners were detected in at least one fish sample from each collection area, including the BSB reference area at Huntington Flats. Maximum calculated values for Total PCBs (Table 3-19) were 171,000 pg/g in sample HFBSB-2016-13, and 164,000 pg/g in sample

HFBSB-2016-19, both from the Huntington Flats collection area. The minimum value for Total PCBs in any single sample was 3,770 pg/g in BSB sample Z2BSB-2014-12 from Zone 2. The twelve dioxin-like PCB congeners were consistently detected, albeit at low concentrations; of these twelve congeners, PCB 126 was detected at a maximum concentration of 58.1 pg/g in a sample from Huntington Flats (HFBSB-2016-13; Appendix V). When examining Total PCBs in BSB by collection area (Table 3-19), Huntington Flats had the highest maximum and average values (see discussion in Section 4.3.2).

3.3.3.2 PCBs in White Croaker

All 46 target PCB congeners were detected in at least one fish sample from each collection area, except for PCB 169, which was not reported in samples from the WC reference area at Ventura Flats. The maximum concentration for a PCB target congener was 35,300 pg/g for PCB 153 in sample Z2WC-2014-18, but care must be taken when assessing the maximum individual PCB data, due to the potential addition of non-target PCB co-elutes. The twelve dioxin-like PCB congeners were consistently detected at low concentrations. Maximum values for Total PCBs were 256,000 pg/g in sample Z2WC-2014-18 and 225,000 pg/g in sample Z2WC-2014-15, both from Zone 2. Like the DDT results for WC, the maximum Total PCBs concentrations occurred in Zones 1 and 2. The minimum value for Total PCBs was 1,340 pg/g in sample VFWC-2015-03 from Ventura Flats. When examining Total PCBs in WC by collection area (Table 3-19), Zone 2 had the greatest maximum and average values.

3.3.4 Total Lipids in Fish Tissue

Reported values of total lipids ranged from 0.539% to 4.52% in BSB, and from 0.931% to 6.06% in WC. These low levels of lipids in skin-off filets were expected and are consistent with previous lipids data from the Sanitation Districts. Lipid normalization was not performed on this contaminant data set, and no further lipids data evaluation was made. The percent-lipids results for each fish are presented in the DDT results tables in Appendix U. Appendix W includes the complete reports from the analytical laboratory.

4.0 DISCUSSION

This section discusses the results for each of the environmental media, i.e., sediment, water, and fish. Topics include chemical data quality; patterns of COC contamination; temporal trends of contamination; comparisons to cleanup criteria; and uncertainty in the sampling and testing.

4.1 SEDIMENT

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

4.1.1 Data Quality Assessment

As previously discussed, analytical data were reviewed and validated following procedures specified in the sediment QAPP (ITSI Gilbane, 2013a). The 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 shelf-wide samples and the data for the OA samples. The QCSRs indicate that project data quality objectives (DQOs) were met. The qualified data are of acceptable quality, and should be considered usable to help determine whether the mass of contaminants is continuing to decrease. The rejected results, while not useable for their intended purposes, represent less than 0.1% of the total dataset. QCSRs for the shelf-wide and OA data sets are included in Appendix N.

Of the more than 29,000 primary sample results for the shelf-wide cores, five results (less than 0.1%) were rejected due to laboratory anomalies, rendering an analytical completeness factor of 99.9%, well exceeding the QAPP goal of 90%. Four shelf-wide samples were found to have insufficient volume for testing for various parameters; however, the field completeness was 99.6%, exceeding the QAPP goal of 90%.

Of the nearly 30,000 primary sample results for the OA cores, seventeen results (less than 0.1%) were rejected due to laboratory anomalies, rendering an analytical completeness factor of 99.9%, again exceeding the QAPP goal of 90%. Three samples were found to have insufficient volume for testing for various parameters (six tests in total); therefore, the field completeness was 99.8%, exceeding the QAPP goal of 90%.

4.1.1.1 Performance Evaluation Sample – Sediment Testing

EPA, with cooperation from the EPA Quality Assurance Technical Services (QATS) program, provided Eurofins CS with a sediment PE sample in May of 2014 to be analyzed and evaluated prior to analysis of project samples. For this sample, Eurofins CS performed the secondary cleanup step described in Section 2.1.6.2 for the analysis of DDTs. This comparison demonstrated that analytical results reported by Eurofins CS for all DDTs, PCBs, and TOC were acceptable, based on the confidence intervals developed for the sample. Results of the PE study are included in Appendix B.

4.1.2 Distribution of COCs

Figures 3-1 and 3-2 are current interpretations of the geometry of the DDT deposit in sediment at PV Shelf. This geometry is consistent with geometries previously reported or postulated by other investigators: the pattern of DDT contamination displays a center of mass near the Sanitation Districts' outfall diffusers, and the DDT concentrations generally diminish with distance from the diffusers. A significant deposit (hot spot) of Total DDTs appears in the 0-8-cm bed-depth interval along the 60-m isobath near the eastern diffuser of the 90-inch outfall. The bottom half of Figure 3-2 shows a cross section illustrating conditions of the sediment bed along the 60-m isobath, based on the 2013 data set. This image illustrates the difference between the 0-8-cm bed-depth interval (the bioactive zone at PV Shelf) and the bed below 8 cm: in the lower portion of the bed, the hot spot extends northwest of the outfalls. (It should be noted that the vertical images on Figures 3-2, 3-4, and 3-6 have a vertical scale factor of about 5,000, and in that regard, are exaggerations of conditions at PV Shelf.)

Figures 3-3 through 3-6 are current interpretations of the geometry of PCBs in sediment at PV Shelf. The pattern of PCBs in the 0-8-cm bed-depth interval shows areas of elevated concentrations in an elongated area that extends seaward (cross-shelf direction) from water depths shallower than 60 m to the PV Shelf break. The vertical profiles illustrate the difference between the 0-8-cm bed-depth interval and the bed below 8 cm, where PCBs appear in elevated concentrations along the 60-m isobath in areas northwest of the Sanitation Districts' outfalls, similar to the pattern of DDTs.

4.1.2.1 Dimensions of the EA Sediment Bed

Based on Figures 3-1 and 3-2, the EA sediment bed covers an area that extends in the along-shelf direction from approximately 3,000 m southeast of the 120-inch (southernmost) outfall to approximately 7,500 m northwest of the northernmost outfall, and in the cross-shelf direction from about the 40-m isobath to past the shelf break.

Appendix X presents a comparison of the 2009 and 2013 shelf-wide cores and OA cores, showing depth in the core versus values of BD_d and the three COC groupings (Total DDTs, Total DDT Compounds, and Total PCBs). The profiles for most cores appear to corroborate the three-layer model described previously (Section 1.2), in that distinct differences in the BD_d values and COC concentrations can be noticed with depth. The 2009 and 2013 profiles display similar patterns in many cores, including 4C, 6C, and 8C, where the highest contaminant concentrations in the two data sets were at nearly identical bed depths in the core.

As was done for the 2009 data set, the EA bed thickness was assumed to be equal to the core length. Using this approach for the 2013 data set, the MVS geostatistical model created a shape of the EA bed with an estimated volume of 15 million m^3, equivalent to the volume modeled in 2009.

4.1.2.2 Temporal Changes in the EA Deposit

<u>Changes in Spatial Distribution of Contaminants</u>

The general shape of the EA deposit does not appear to have changed appreciably since previous sediment sampling events. Location BA8C near the Sanitation Districts' diffusers appears to represent the most contaminated area on PV Shelf: for the 2013 data set, maximum concentrations of both Total DDT Compounds and Total PCBs were found in core BA8C.

Figure 4-1 illustrates the differences in DDT concentrations in the top 2 cm of the sediment bed between 2002/2004, 2009, and 2013. Figure 4-2 shows the comparison of DDTs in the 0-8-cm bed layer (the bioactive layer) between 2009 and 2013. Figures 4-3 and 4-4 present the corresponding data for PCBs.

For the top 2 cm of the sediment bed, concentrations of both DDTs and PCBs appear to have decreased significantly since 2002/2004, notably near the Sanitation Districts' outfall diffusers.

(It is acknowledged that different sampling methods were used for the 2002/2004 event than those used in 2009 and 2013). For the 0-8-cm bed-depth interval, concentrations of DDTs and PCBs show overall increases between 2009 and 2013 for a major portion of the sampled area. Possible contributing factors for the increases include: (1) lower RLs achieved by Eurofins CS for the 2013 event for DDT and PCBs as compared to RLs previously used; and (2) uncertainties in the chemical analysis and modeling (Sections 4.4.1.3 and 4.4.1.4); and (3) heterogeneity of the deposit, as indicated by the high variability seen in the field replicate evaluation (Appendix Y).

Average Concentrations and Mass of Contaminants

As previously noted, Table 3-7 presents estimates for the average concentrations of COC groupings for the entire data set and the OA data set, and Table 3-8 presents estimates of the mass of COCs for the entire data set and the OA data set. Results for both the 2009 and 2013 data sets are shown. The results indicate that significant amount of DDTs and PCBs remain in sediment at PV Shelf. Though average and mass values for 2013 were greater than corresponding values for 2009, overall, mass of COCs has decreased over time, when compared to previous mass calculations (prior to the IROD).

Regarding estimates of COC mass, previous researchers have focused on p,p'-DDE, as this isomer was regarded as the most prevalent DDT form on the shelf, and hence representative of contaminants in the sediment bed (Lee, 1994). Table 4-1 summarizes estimates of the masses of p,p'-DDE and PCBs by various researchers and indicates the wide differences between studies. The 30 MT value for p,p'-DDE calculated by the MVS model based on the 2013 data set is greater than the 9.7 MT and 13.8 MT values for p,p'-DDE calculated by the two separate MVS models based on the 2009 data set. However, as mentioned above, the mass values derived from the 2009 and 2013 sediment data sets were significantly lower than those for 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

Both for 2013 and 2009, the OA cores as depicted in Figure 2-2 (and in the MVS model) were within 1.5 km of any outfall diffuser section. For the 0-8-cm bed-depth interval, based on the 2013 data set, the OA contains approximately 47% of the entire mass of each COC grouping (i.e., Total DDTs, Total DDT Compounds, and Total PCBs). For the same bed-depth interval, based on the 2009 data set, the OA contained about 53% of the COC mass.

4.1.3 Comparison of Sediment Data to Cleanup Goals

As previously described, the IROD established the following objectives of the interim isolation cap:

- The 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.

As previously described, the 2013 sediment data set was input into the MVS geostatistical model; the model output included the average (mean) concentrations of COCs in the sediment bed (Table 3-7). For the 2013 data set, the mean value of Total DDTs OC in the 0-8-cm bed-depth interval was 77 mg/kg OC (77,000 ug/kg OC). This value is just under the cap placement objective of 78 mg/kg OC. For PCBs (short list), the model output mean value of 5 mg/kg OC (5,000 ug/kg OC), also is under the interim sediment cleanup level of 7 mg/kg OC.

4.1.4 Sediment Uncertainties and Possible Sources of Error

4.1.4.1 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). During the 2013 coring event, a camera mounted on the coring device, as described in Section 2.1.4, recorded the progress of the drop through the water column and into the sediment bed. Review of the videos (Appendix E) show that, though blowoff of fine sediment away from (external to) the coring device is evident at the moment of impact of the device into the seafloor, there is no evidence of advance blowoff (movement of sediment ahead of impact), and there is no evidence of sediment escaping from the coring device at impact. There is no evidence of incomplete cores, provided that the entry angle is plumb to the sediment bed surface.

Vertical profiles (Appendix X) indicate that the bottom of the EA bed may not have been reached in several cores, based on elevated COC concentrations reported for samples generated for the core bottom. However, this limitation is balanced by the fact that all cores were collected using the same methodology, for both the 2009 and 2013 events.

4.1.4.2 Spatial Uncertainty

The coring frequency of the shelf-wide sampling was 34 cores over a modeled area of 30 km^2, correlating to one core per 0.9 km^2. At the OA, the coring frequency (including the shelf-wide cores from Sanitation Districts Transects 6 through 9) was 51 cores over a modeled area of 11 km^2, correlating to one core per 0.2 km^2. The OA coring frequency was improved from the coverage of 0.3 km^2 achieved in the 2009 sampling event.

4.1.4.3 Laboratory Uncertainty

Aliquots of select samples from cores BA5B, BA6BC, BA9C, OA10, and OA11for the 2009 and 2013 sediment collections were retrieved from the Sanitation Districts' deep-freeze archive. The aliquots were extracted and analyzed in a single analytical batch by a single extraction technician and a single analyst at Eurofins CS in March 2017 (this approach was intended to minimize laboratory contribution to the uncertainty). Results of the analyses are presented in Table 4-2. The heterogeneity of the sample matrix is illustrated by R^2 values of 0.657 for p,p'-DDE and 0.627 for Total PCBs (short list) calculated for the 2009 versus the 2013 data sets (Appendix O). These R^2 values do not indicate a strong correlation for the two data sets. Another indication of the heterogeneity of the sample matrix is found in Appendix Z, which presents a graphical comparison of average p,p'-DDE concentrations for the 0-8-cm sediment layer between the 2009 and 2013 data sets.

4.1.4.4 Uncertainty in the Geostatistical Model

As described previously, Appendix C provides a detailed discussion of the MVS geostatistical modeling effort used on the sediment data set. The model output included values of mean (average) COC concentrations (OC normalized) and values of mass of COCs. The model also calculated values of "uncertainty" and "confidence" for the COC summations at each modeled node; the mean value of confidence for the entire sediment data set was reported as greater than 65%. The modeling report concludes that the site is well characterized for COCs.

To further bolster confidence in the sediment model, EPA sponsored a secondary geostatistical modeling effort independent of the primary effort, but using the identical sediment data set. The modeling was conducted by Sundance, Albuquerque, New Mexico. Sundance, in its model output, also produced values for average COCs OC normalized, and total COC mass, both for the entire sediment bed and for the 0-8-cm bed-depth interval. Appendix AA is a report that describes the modeling effort and the model output.

Table 4-3 summarizes model outputs from the primary and secondary geostatistical models, along with values of relative percent difference (RPD). As indicated, the secondary effort produced values of average concentrations that were generally about 20-to-30% lower than the primary model. Values of total COC mass in the entire (shelf-wide) bed were also lower in the output of the secondary model. The mass values for the 0-8-cm bed-depth interval varied slightly higher for Total DDTs and Total DDT Compounds, and slightly lower for Total PCBs. The RPD values for the model comparison are considered acceptable; as such, the secondary modeling effort validates the findings and output of the primary effort.

4.2 WATER COLUMN

4.2.1 Data Quality Assessment – Water Column (High Resolution)

Water sampling analytical data were reviewed and validated by an independent third-party validator following procedures specified in the water QAPP (Gilbane, 2014). Of the 6,850 primary sample results for the water sampling program, 13 results (less than 0.2%) in two samples, were rejected due to laboratory QC anomalies, for a data completeness of 99.8%, well above the QAPP goal of 90%.

The Gilbane project chemist conducted an overall QC review after receiving the data validation reports, and developed a QCSR to summarize the data quality anomalies for the water sampling program. The QCSR indicate that project DQOs were met and that all non-rejected data were usable for assessing vertical ocean water column concentrations. Laboratory reports and the QCSR for the high resolution water data set are presented in Appendix S.

4.2.2 Data Quality Assessment – Water Column (PSDs)

The PSD results were reviewed against the field QC requirements for PSD sampling presented in the PSD QAPP (Fluen Point Environmental, 2013) by the Gilbane project chemists. A total of

14 PED and four SPME field blanks were collected and analyzed. All were non-detected for both DDTs and PCBs. A minimum of three field replicates was required by the sampling design; each sample was deployed in triplicate. The results were reported as averages; therefore an evaluation of RPDs was not applicable.

The planned PSD sample collection total was 153 primary PEDs and 54 SPMEs. Several PEDs were lost during deployment: one surface sampler was missing from station 7C, all three surface samplers were missing from stations 8C and 9C, and one near-bottom sampler was missing from station W3. Also, an entire mooring line from station W5 was not recovered. All SPME samplers were recovered; however, two failed before they could be analyzed (one of three from near-bottom at station 4C and one of three from near-bottom at station 7C). Overall, this represents a combined PSD field sampling completeness of 90.8%.

4.2.3 Distribution of COCs in the Water Column

Figures 3-6 and 3-7 present concentrations of p,p'-DDE for the water column at each sampling location; Figures 3-8 and 3-9 show concentrations of Total DDTs for the same locations. The patterns of contamination were very similar; this similarity is expected, because the contribution of p,p'-DDE made up more than 70% of the concentrations of Total DDTs in most samples (Appendix Q). In general, the bottom and near-bottom samples had higher concentrations than mid-column samples, with some exceptions at locations BA3C, BA3DC, BA4B, and BA7C, where elevated mid-column concentrations were measured. All near-surface samples have low p,p'-DDE and Total DDTs concentrations.

Tables 3-10, 3-11, and 3-12 show results for Total DDT Compounds along the 150-m, 60-m, and 40-m isobaths, respectively; the sample locations were grouped by water depth, and by distance relative to the Sanitation Districts' outfall diffusers. In examining vertical trends, concentrations generally were highest either in the near-bottom or mid-column samples along all isobaths. Average concentrations were all greatest in the near-bottom locations, lower in mid-column samples (except in the vicinity of the outfall diffusers along the 60-m isobath), and always lowest for the near-surface samples.

For along-shelf trends, concentrations generally were highest down-current of the outfalls, with elevated Total DDT Compounds concentrations from transects BA7 through BA3, while up-current concentrations (transects BA9 and BA10) were relatively low. For cross-shelf trends between the 150-m, 60-m, and 40-m isobaths, the down-current concentration maxima and averages were similar at each sample depth, but in the vicinity of the outfall diffusers, the near-bottom concentrations along the 40-m isobath and the mid-column sample results along the 60-m isobath were greater.

Table 4-4 compares values for dissolved-phase DDTs from: (1) a SCCWRP event from 1999 (Zeng et al., 1999); (2) an EPA PSD sampling event from 2012 (Fernandez, 2012); (3) an EPA PSD sampling event from a draft data summary (Fernandez, 2015; see Appendix D); and (4) EPA's 2015 high resolution event described herein. In general, higher concentrations were measured in samples collected near the bottom of the water column (i.e., close to the sediment bed surface) during all sampling events. It also appears that the SCCWRP results are comparable to those from the PSD events. However, these results exceed by roughly an order of magnitude the results from the high resolution sampling event, for bottom and near-bottom samples.

Concentrations of dissolved-phase DDTs at PV Shelf would be expected to decline over time due to dispersion and mixing in the open ocean, and a net reduction of contaminated sediment exposed to the water column due to deposition of cleaner surface sediment. In that regard, the PSD results could be biased high. The high resolution grab sample results were significantly lower than the PSD results, but the general trend is similar in that elevated DDTs were detected in bottom or near-bottom samples at locations BA4C, BA5C, BA5DC, BA6DC, and BA7DC.

Figures 3-10 and 3-11 present high resolution concentrations of Total PCBs in water. In a pattern similar to that of p,p'-DDE, relatively high PCBs concentrations were reported for each transect from BA9 down-current through BA3. In general, the bottom and near-bottom samples had higher PCBs concentrations than mid-column samples, with some exceptions at locations BA3DC, BA4B, BA7C, BA8DC, and BA9DC, where elevated mid-column concentrations were measured. All near-surface samples have relatively low PCBs concentrations.

Tables 3-13, 3-14, and 3-15 show results for Total PCBs along the 150-m, 60-m, and 40-m isobaths, respectively, with the sample locations grouped by distance relative to the outfall diffusers. The vertical trends were similar to those for Total DDT Compounds, where concentrations generally were highest in the near-bottom or mid-column samples along all isobaths. Average concentrations were greatest in the near-bottom samples, lower for samples collected at mid-column depths (except in the vicinity of the outfall diffusers along the 60-m isobath and up-current of the diffusers along the 40-m isobath), and always lowest for the near-surface samples.

The along-shelf PCBs concentrations generally were highest down-current of the outfall diffusers, with elevated concentrations from transects BA9 through BA2; concentrations were relatively low for up-current transect BA10. For cross-shelf trends between the 150-m, 60-m, and 40-m isobaths, the down-current concentration maxima and averages were similar at each sample depth (similar to the Total DDT Compounds concentrations); but in the vicinity of the outfall diffusers, the near-bottom sample concentrations along the 40-m isobath and the mid-column results along the 60-m isobath are greater.

Table 4-5 compares dissolved-phase PCBs results from the various PV Shelf sampling events previously described for DDTs. Similar to the DDTs comparison, the concentrations of Total PCBs in the near-bottom and bottom samples were higher than those in mid-column and near-surface samples (with an exception for the near-surface sample at BA7C).

SCCWRP's dissolved-phase results were higher than results for most other samples from similar depths, followed by results from near-bottom PEDs in 2013. The PED data from 2010 and shallower PED data from 2013 are generally comparable to the grab sample results from 2015. Dissolved-phase concentrations of PCBs, like those of DDTs, would be expected to decrease over time. SCCWRP's bottom-sample concentrations were greater than the concentrations in the 2010 and 2013 PEDs, and a downward trend continues in the 2015 grab samples, showing an overall decreasing trend for PCBs. The high resolution sample results from 2015 generally were lower than those for the other sampling events, but still show elevated PCBs in many bottom or near-bottom samples, and in mid-column samples from locations BA6C, BA7C, BA8DC, and BA9DC. One near-surface grab sample at BA7C was also anomalously high.

Figure 4-5 shows near-bottom concentrations of Total DDTs in the water column along the 150-m, 60-m, and 40-m isobaths, in relation to concentrations in sediment in the 0-2-cm bed-depth interval. Elevated concentrations of DDTs in water samples extend from transect BA7, northwest (down-current) of the outfall diffusers, to beyond transect BA3 and the isobath boundaries, in a similar pattern to the elevated DDTs in the 0-2-cm sediment bed-depth interval.

Figure 4-6 is the equivalent figure for Total PCBs, and shows a widespread pattern of elevated concentrations, both in the near-bottom water column and in the 0-2-cm sediment bed-depth interval. The area of elevated PCBs extends from near location BA9B, down-current beyond location BA2B, and to the boundary of the sample coverage area.

4.2.4 Comparison of High Resolution Water Data to Cleanup Goals

For assessing possible risks to human and ecological health resulting from exposure to COCs in the water column, sample results (concentrations) were listed and compared to applicable cleanup goals on a point-by-point basis, as described below.

4.2.4.1 DDTs

The 2009 IROD established cleanup goals for DDTs in water, citing EPA's AWQC in effect at that time. The IROD AWQC as they apply to DDTs at PV Shelf are as follows:

- The human health AWQC is 0.22 ng/L for p,p'-DDE.[3]
- The ecological (saltwater aquatic life) AWQC is 1 ng/L for Total DDTs.

The high resolution results indicated that concentrations of p,p'-DDE exceeded the human health AWQC in 41 primary or replicate samples, and concentrations of Total DDTs exceeded the ecological AWQC in seven samples (Appendix Q). Locations of p,p-DDE exceedances are shown on Figures 3-6 and 3-7. Locations of exceedances for Total DDTs are shown on Figures 3-8 and 3-9. The patterns of p,p'-DDE and Total DDTs concentrations are similar since p,p'-DDE constitutes more than 70% of the Total DDTs result in most samples. Except for transect BA2, multiple AWQC (human health) exceedances of p,p'-DDE concentrations extend from transect BA8 down-current through BA1 (Figures 3-6 and 3-7). AWQC (ecological) exceedances for Total DDTs are limited to transects BA4 and BA7 (Figures 3-8 and 3-9).

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[3] For assessing possible human health impacts related to DDTs in the water column, the EPA used the AWQC for p,p'-DDE (0.22 ng/L). Use of this criterion is justified because, in terms of frequency and magnitude of detections, p,p'-DDE is the most prevalent DDT form in the water column (and in other media) at PV Shelf, and its AWQC value is more conservative than that for p,p'-DDD (0.31 ng/L) and equally conservative to that for p,p'-DDT (0.22 ng/L).

4.2.4.2 PCBs

The IROD established cleanup goals for PCBs in water, again citing EPA's AWQC. The IROD AWQC as they apply to PCBs at PV Shelf are as follows:

- The human health AWQC is 0.064 ng/L for Total PCBs.
- The ecological (saltwater aquatic life) AWQC is 30 ng/L for Total PCBs.

No other cleanup goals for PCBs in water were established in the IROD.

Concentrations of Total PCBs exceeded the AWQC for human health in 38 of 146 water samples. Appendix R presents all exceedances of the IROD AWQC for Total PCBs in shaded cells. Figures 3-10 and 3-11 present concentrations of Total PCBs in the water column. Similar to p,p'-DDE, Total PCBs at concentrations above the human health AWQC extend from transect BA9 down-current through BA3.

4.2.5 Water Column Uncertainties

4.2.5.1 Sampling Procedures

There are difficulties inherent in collecting ocean grab water samples at the depths and pressures attempted in this study. Samples were collected at sea directly into sample bottles; this approach was efficient in that it required no transfer of samples between bottles, and time-consuming decontamination procedures and associated handling of wastes were minimized.

Previous sampling events may have had the following sampling limitations: pumped samples required 1,100 to 2,300 L to be pumped through a filter and Teflon XAD-II resin column over several days for each sample (Zeng, 1999); and PSD samples required precise infusion of isotope-labelled compounds into each sampling device prior to each event, 30-day deployments for sampler equilibration allowing for sampler losses, and calculations for sampler concentrations based on variable water-polyethylene partitioning coefficients and temperature corrections (Fernandez, 2012, 2015).

The approach of grab sampling combined with high resolution analyses, by contrast, takes less labor and time; attains lower detection limits; and is representative of actual depth-specific water column conditions at the time of collection. For these reasons, this approach is recommended for future sampling at PV Shelf.

The two main sampling events for this MNR report were performed in March and September 2015, and this may lead to some temporal variability. The locations collected in March were BA8C, BA9DC, and W4. A review of the DDT and PCB results at these locations does not show any apparent anomalies or temporal bias between adjacent sampling locations. In Zeng's study, water column samples for DDTs and PCBs were collected in winter and summer 1997, but temporal trends were inconsistent and seasonal variability was not apparent (Zeng, 1999). Other possible variables that may affect COC concentrations in water include ocean currents, tidal influences, temperature and salinity cycles, and sedimentation patterns.

4.2.5.2 Laboratory Uncertainty

The high-resolution grab samples were filtered at the laboratory through glass fiber filters of nominal pore size of 0.7 um; this size was identical to the filters used by Zeng in the field (1999). Unlike Zeng, however, the filters were not analyzed to determine COC concentrations in the particulates retained on the filter. Colloids smaller than 0.7 um may be adsorbed (lost from the filtrate) to the surfaces of laboratory glassware. The filtrates were subjected to GPC and silica gel cleanup (SGC) to remove potential biological and hydrocarbon interferences, and this approach may also remove some colloids from the sample. These factors may affect the final reported concentrations of dissolved contaminants.

The values of target PCB congeners reported with co-elutions have a degree of uncertainty. For this water study, 14 target congeners had co-elutions (Table 2-3), and the reported values for these 14 congeners may have been biased high. For example, the PCB 70/74 results report the co-eluted target congeners, but also report non-target congeners PCB 61 and PCB 76.

4.2.5.3 Spatial Uncertainty

Horizontal accuracy using DGPS navigation was estimated to be within 3 m. However, during each sampler deployment, the propellers were stopped for variable amounts of time, leading to tidal drift and an estimated location error up to ±40 m. For each sampler deployment, the sample depth error is estimated as ±1.5 m, due to ocean swells and drift away from the vertical of the sampling device on the wire cable.

Horizontal and vertical location errors lead to changes in the exact grab sample location for consecutive sampler deployments for adjacent near-bottom and bottom samples, and for field replicates. Despite the temporal and spatial variability, the depth comparability of the DDTs and PCBs data sets were internally consistent at each location, the field replicate precision was good, and the results appear representative of the ocean water conditions at the time of sample collection.

4.3 FISH

The IROD established interim cleanup levels for environmental media. This section discusses the MNR results with respect to the cleanup levels.

4.3.1 Data Quality Assessment – Fish

The fish tissue analytical data were reviewed and validated by an independent third-party validator following procedures specified in the fish QAPP (Gilbane, 2016a). A total of 6,850 primary sample results was generated for the fish sampling program, and no data points were rejected; thus, the analytical completeness was 100%. The planned fish collection total was 340, and the actual number of fish caught over a 27-month period (from June 2014 through August 2016) was 301, for a field sampling completeness of 89%.

The Gilbane project chemist conducted an overall QC review after receiving the data validation reports, and developed a QCSR to summarize the data quality anomalies for the fish sampling program. The QCSR indicated that project DQOs were met and that all data were usable for assessing fish tissue concentrations. The QCSR for the fish data set is presented in Appendix W.

The laboratory RLs were evaluated by the project team prior to sample collection to confirm that the laboratory was able to attain the required sensitivity for the project. For the tests for pesticides and PCBs, the reporting approach was to report each DDT isomer and PCB congener to a sample-specific EDL. The level of sensitivity achieved by HRGC/HRMS analysis for DDTs and PCBs is the lowest technically achievable, and met project objectives. All fish data are useable, as qualified, for comparison to the IROD target fish tissue concentration goals.

4.3.2 Distribution of COCs in Fish

As previously mentioned, Figure 3-12 shows COC results for BSB and WC for each collection area, including minimum, average, and maximum concentrations of Total DDTs and Total PCBs.

4.3.2.1 DDTs

For BSB, there is an overall pattern of higher DDTs concentrations in samples of fish caught in EPA Zones 1 and 2 (near the Sanitation Districts' outfall diffusers). Samples of fish caught in the reference BSB collection area at Huntington Flats had elevated average and maximum concentrations of Total DDTs. The high maximum concentrations at the Huntington Flats reference area for DDTs in BSB may be indicative of individual fish having a significant contaminant load during summer spawning migration from PV Shelf or the ports of Los Angeles and Long Beach (ITSI Gilbane, 2013b), and do not appear to represent the local potential exposure of BSB to sediment conditions at Huntington Flats.

For WC, Figure 3-12 shows that the average and maximum Total DDTs values from Zones 1, 2, and 3 being higher than the corresponding values for the other collection areas. Significant concentrations of Total DDTs are also noted in the Breakwater Zone and Redondo Flats. The reference WC collection area at Ventura Flats has very low concentrations for DDTs. The widespread area of elevated DDTs concentrations in WC may be indicative of the fishes' wide range and mobility, and provide evidence of their apparent low site fidelity to the vicinity of the Sanitation Districts' outfalls area (Lowe, 2013).

4.3.2.2 PCBs

An overall pattern of higher PCBs concentrations in BSB from Zones 1 and 2 is apparent. BSB caught at reference collection area Huntington Flats also had elevated average and maximum concentrations of Total PCBs, comparable to Zone 2, but less than Zone 1. A small number of BSB from Huntington Flats (and to a lesser extent Redondo Flats and the Breakwater Zone) had high concentrations of PCBs, resulting in elevated maximum and average Total PCBs concentrations. The elevated concentrations of PCBs at Huntington Flats, like those of DDTs, may indicate that individual fish migrated from PV Shelf or the shipping harbors, and that these concentrations are not necessarily representative of sediment conditions at Huntington Flats.

For PCBs in WC, Zones 1, 2, and 3 all had maximum concentrations exceeding 150,000 pg/g. The collection area with the highest average value for PCBs was Zone 1 at the outfall diffusers. Redondo Flats (northwest of the diffusers) and the Breakwater Zone (east of the diffusers) both showed significant levels of PCBs when compared to the Ventura Flats reference area. It appears that elevated PCB concentrations in WC are more widespread than for BSB. This phenomenon may be related to the wide range and mobility of WC, as noted in previous studies (Lowe, 2013).

4.3.2.3 Time Trends

At this time, a meaningful analysis of time trends for fish at PV Shelf is difficult due to many factors, including fish mobility; differences in fish collection locations and depths by different researchers; differences in analyte lists; and differences in analytical procedures. Tables 4-6 and 4-7 show summaries of DDT and PCB data, respectively, generated from: NOAA's 2002/2004 study (NOAA/EPA, 2007); recent EPA studies from shallower pier fishing locations related to the ICs program (WC only; Gilbane, 2016b, 2017); the Sanitation Districts' 2012 (BSB) and 2015 (WC) data (Sanitation Districts, 2014, 2016); and this MNR study. An attempt was made to align locations of fish collections from these various efforts to examine time trends. There are more data available for WC than for BSB, as WC have been collected more consistently.

For DDTs, when comparing the NOAA 2002/2004 data set with the current MNR data set, the maximum and average DDTs results have decreased in both BSB and WC from 2002 to 2016 at all collection areas except the Breakwater Area. For WC at Zones 1, 2, and 3, where Sanitation Districts' data are available (collections in November and December 2015) and where comparisons can be made, the composited results for WC are notably higher than the averages from both the NOAA 2002/2004 study (Zones 1 and 2 only; collected from September 2002 to June 2004) and the 2014/2016 MNR study (October 2014 to July 2016 collections). For BSB at Zones 1, 2, and 3, the Sanitation Districts' results for DDTs for composited samples (collected from June to October 2012) are notably lower than the averages from the NOAA 2002/2004 study (Zones 1 and 3 only; collections from August 2002 to June 2003), and the 2014/2016 MNR study (Zones 1, 2, and 3; June 2014 to August 2016 collections). There are inadequate data to make more detailed observations.

For PCBs (collected concurrently with the DDTs), when comparing the NOAA 2002/2004 data set with the current MNR data set, the maximum and average PCBs results have decreased at all collection areas except Redondo Flats. For WC, decreases in average values were noted at Zones 1 and 2. For BSB at Zones 1, 2, and 3, the Sanitation Districts' results for total detectable Aroclors (total PCB congeners are not available) in composited samples, are consistent with the decreasing average concentrations trend from the higher NOAA 2002/2004 study (Zones 1 and 3 only), to the lower 2014/2016 MNR study. Due to incomplete and inconsistent data sets, there are no other discernable time trends that can be made at present.

The Sanitation Districts has generated data on DDTs and PCBs in WC routinely since the late 1990s. For the collection areas closest to the outfalls, the data set shows dramatic decreases for DDTs in WC samples. Concentrations of PCBs in WC have remained consistent, but at low concentrations relative to DDTs (EPA, 2009b; Sanitation Districts, 2016).

4.3.3 Comparison of Fish Data to Cleanup Goals

The IROD established the following cleanup goals for protection of human health from ingestion of WC (the IROD did not establish cleanup goals for ingestion of BSB):

- For DDTs, 400 ug/kg
- For PCBs, 70 ug/kg

For PV Shelf, the adopted approach is to derive a representative EPC specific to each EPA fish collection area. For this data set, for each collection area, ProUCL software (EPA, 2015) was used to calculate the 95% upper confidence limit (UCL) on the mean concentration; this value is regarded as the area-specific EPC. The use of the 95% UCL on the mean is widely recognized as a conservative estimate for representing an EPC. This approach is recommended when conducting quantitative exposure assessments of contaminants in environmental media including fish tissue (EPA, 1989), and has been applied for the ICs program at PV Shelf (Gilbane, 2016b, 2017).

Figure 3-12 shows that for Total DDTs, the EPCs exceeded the cleanup goal in fish collection areas EPA Zone 1, EPA Zone 2, and EPA Zone 3. For Total PCBs, the EPCs exceeded the cleanup goal in collection areas EPA Zone 1, EPA Zone 2, and Redondo Flats. The EPC for DDTs in EPA Zone 3 and the EPC for PCBs at Redondo Flats exceed the IROD cleanup goals. EPA Zone 3 and Redondo Flats are outside the CDFW commercial WC catch ban area.

4.3.4 Fish Uncertainties

4.3.4.1 Collection Procedures

The fish sampling design has an inherent and unknown degree of uncertainty, since it is not intended to ascertain the environments to which each fish collected during this task has been exposed in its life cycle. It is impossible to know where a fish has travelled, what its feeding habits are, and where it has received its contaminant body burden. Further, it is not possible to determine the degree to which direct sediment contaminant exposure has occurred for each fish.

A wide variety of fish lengths and weights were measured in each species; however, no evaluation of potential age biases to fish contaminant exposure uncertainties was made. Fish tend to absorb contaminants throughout their lifetimes. For future events, the age of each fish and/or body burden based on weights and measures, should be assessed.

Fish samples were prepared as skin-off filets, and estimated concentrations in whole fish were not generated. Also, while lipid results were generated for each sample (Appendix U), lipid normalization was not performed for this study, but could be calculated in future assessments. There is typically a linear relationship between fat content and organo-chlorine content in fish; lipid normalizing is an approach to assess whether changes (over time) in contaminant concentration indicate an actual trend or are attributable to changes in fat content in the fish (EPA, 2000b).

4.3.4.2 Spatial Uncertainty

Due to the limited availability of fish, the actual collection locations for several BSB at Breakwater Zone and Redondo Flats, for several WC at Redondo Flats, and for most fish at EPA Zone 1, EPA Zone 2, and EPA Zone 3, were outside the designated boundaries of the planned 5-km by 1-km collection areas indicated on Figures 2-5 and 3-12. All fish collection locations were recorded and are included in
Appendix T.

5.0 CONCLUSIONS

This section presents the conclusions for the first MNR report. Table 5-1 is a summary of compliance with IROD criteria, organized by medium.

5.1 SEDIMENT

Sediment cores were retrieved successfully from 34 locations for the shelf-wide program, and from 35 OA locations (near the Sanitation Districts' 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 shelf-wide sampling program, the approach used for this study provided a sufficient data set with a level of confidence that allows for meaningful comparison to the 2009 data set as well as to any future data sets established to assess the progress of cleanup of DDT and PCBs.

The output from the geostatistical models indicated a widespread pattern of DDT contamination similar to EPA's 2009 data set and to patterns reported by previous investigators, including the Sanitation Districts and USGS. The model output also indicated a pattern of PCB contamination similar to EPA's 2009 data set. The pattern is similar to that of DDTs, with areas of higher concentrations at the Sanitation Districts' outfalls, but also with elevated concentrations extending seaward into deep water, and in areas both northwest and southeast of the outfalls.

Although interpretive patterns of COCs in the EA deposit have not changed appreciably over time, detected contaminant concentrations in surface sediment (0-2-cm bed-depth interval) have dropped significantly since 2002/2004. It is plausible that this is caused by deposition of clean material, and several factors of MNR, including: dechlorination; sediment erosion; and sediment resuspension with associated desorption of COCs from sediment into seawater (EPA, 2005).

Model output indicated an increase in COC mass between 2009 and 2013, though the mass values remain well below historical estimates. The apparent increase between 2009 and 2013 may be a function of the uncertainties in the sampling and analysis techniques, differences in MVS model assumptions, and in the demonstrated heterogeneity of the sediment deposit itself.

Model output also indicated mean (average) COC concentrations for the 0-8-cm bed-depth interval derived from the 2013 data set to be 77 mg/kg OC for Total DDTs and 5 mg/kg OC for Total PCBs (short list). These values were below the short-term objectives identified for the interim isolation cap (78 mg/kg OC DDTs; 7 mg/kg OC PCBs), as they were in 2009.

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 bed-depth interval; these samples were obtained using a different collection method from that used in the 2009 and 2013 coring programs. Because the results of EPA's coring programs present a picture of environmental conditions at PV Shelf significantly different than what was historically understood, and it is important to obtain a better understanding of actual site conditions, future sampling programs should be conducted using techniques similar to those used for the 2009 and 2013 programs.

5.2 WATER

Spatial distributions of DDTs and PCBs in the water column at PV Shelf were evaluated using two different methods:

- Water samples using a depth-discrete grab sampling method and then analyzing filtered samples using HRGC/HRMS for eight individual DDT forms and for 46 PCB congeners.
- PSDs were first prepared by impregnating with PRCs, then deployed at sea for approximately 30 days. The PSDs were then retrieved and lab-analyzed for DDTs and PCBs.

For both methods, summations of Total DDTs, Total DDT Compounds, and Total PCBs were calculated. The areal distributions of DDTs and PCBs in water appear similar to those found in shallow sediment, and the vertical concentration profiles of DDTs and PCBs at most water sampling locations decreased with increasing distance from the sea floor. The comparison of current high resolution water sampling results to previous water column data shows a general overall trend toward lower concentrations over time. These findings appear to confirm that contaminated sediments are a slowly decreasing source of DDT and PCB inputs to the water column at PV Shelf. However, concentrations of dissolved-phase p,p'-DDE and for PCBs exceed the corresponding IROD cleanup goals for human exposure in several locations and at several depth intervals. Exceedances of the IROD cleanup goal for dissolved-phase Total DDTs (ecological exposure) are less frequent.

5.3 FISH

Specimens of two fish species (BSB and WC) were caught during 2014 to 2016 from seven collection areas in the vicinity of PV Shelf. Concentrations of DDTs and PCBs in samples of fish tissue (skin-off filets) were measured using HRGC/HRMS techniques. The distribution patterns of DDTs and PCBs in each fish collection area were similar to those found in the sediment, and the average concentrations of DDTs and PCBs in fish from most collection areas decreased with increasing distance from the Sanitation Districts' outfalls (with the noted exception of BSB from Huntington Flats). The comparison of these results to previous fish sampling data indicates that maximum and average DDTs and PCBs concentrations have decreased since 2002 for both BSB and WC. However, EPC concentrations in WC remain higher than the IROD cleanup goal at several fish collection areas, most notably at the areas closest to the outfall diffusers, on PV Shelf. These findings suggest that contaminated sediment continues to be a source for DDT and PCB inputs to fish at PV Shelf, but that the likely input rate is decreasing.

5.4 SUMMARY

Conditions at PV Shelf regarding COC contamination appear to be improving – concentrations in the sediment 0-2-cm bed-depth interval continue to improve, and concentrations in the 0-8-cm bed-depth interval met the concentration performance objectives related to the interim cap described in the IROD, even without the cap. However, significant areas of sediment remain highly contaminated, and COC concentrations in samples of water and fish exceeded the associated IROD cleanup goals, both for DDTs and PCBs. EPA will continue the MNR sampling program to evaluate the effectiveness of MNR and to develop final remediation alternatives for PV Shelf cleanup.

6.0 REFERENCES

California Department of Fish and Wildlife (CDFW), 1990. Establishment of a commercial catch ban area for white croaker on the Palos Verdes Shelf. California Fish and Game Code § 7715(a) & (b); California Code of Regulations, Title 14, Section 104.

CDFW, 2017. 2017-2018 California Saltwater Sport Fishing Regulations.

California EPA/Office of Environmental Health Hazard Assessment (CalEPA/OEHHA), 2009. Health Advisory and Safe Eating Guidelines for Fish from Coastal Areas of Southern California: Ventura Harbor to San Mateo Point. June.

California Regional Water Quality Control Board (Water Board), 2017. Waste Discharge Requirements and National Pollutant Discharge Elimination System Permit for the Joint Outfall System, Joint Water Pollution Control Plant Discharge to the Pacific Ocean (Order No. R4-2017-0180, NPDES No. CA0053813). 07 September.

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.

Fernandez, L.A., R.M. Burgess, W. Lao, K. Maruya, and C. White, 2012. Passive Sampling to Measure Baseline Dissolved Persistent Organic Pollutant Concentrations in the Water Column of the Palos Verdes Shelf Superfund Site, *Environmental Science & Technology*, Vol.46, pp. 11937-11947.

Fernandez, L.A., 2015. Draft Palos Verdes Shelf 2013 Water Column Passive Samplers Deployment: Data Summary. Fluen Point Environmental, Marblehead, MA. November.

Fluen Point Environmental, 2013. Final Quality Assurance Project Plan (QAPP) for Passive Sampling for Persistent Organochlorine Pollutants (POPs) in the Water Column of the Palos Verdes Shelf (2013). November.

ITSI Gilbane Company (ITSI Gilbane), 2013a. 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.

ITSI Gilbane, 2013b. Revised Final Data Report for the Fall 2009 Sediment Sampling Program, Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site), Los Angeles County, California. November.

Gilbane Federal (Gilbane), 2014. Final Quality Assurance Project Plan (QAPP) - Water Sampling Program, Remedial Action – Monitored Natural Recovery Component, Palos Verdes Shelf, Los Angeles County, California. October.

Gilbane, 2016a. Final Quality Assurance Project Plan (QAPP) - Fish Sampling Program, Remedial Action – Monitored Natural Recovery Component, Palos Verdes Shelf, Los Angeles County, California. January.

Gilbane, 2016b. Technical Memorandum - Risk Evaluation of Fish Monitoring Results and Lobster Data – Palos Verdes Shelf. June.

Gilbane, 2017. Technical Memorandum - Human Health Risk Evaluation of 2011-2012 Fish Collection Data – Palos Verdes Shelf. January.

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.

Lowe, C., 2013. Revised Final Data Report for the Fish Movement Study, Palos Verdes Shelf (OU 5 of the Montrose Chemical Superfund Site), Los Angeles County, California. December.

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.

National Oceanographic and Atmospheric Administration (NOAA), 1998. National Status and Trends Program for Marine Environmental Quality, Chesapeake Bay.

NOAA and United States Environmental Protection Agency (NOAA/EPA), 2007. 2002/2004 Southern California Coastal Marine Fish Contaminants Survey. June.

Sanitation Districts of Los Angeles County (Sanitation Districts), 1992. Palos Verdes Ocean Monitoring: Sediment Report 1992. 31 January.

Sanitation Districts, 2006. Palos Verdes Ocean Monitoring Annual Report 2005. 30 June.

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

Sanitation Districts, 2014. 2012-2013 Joint Water Pollution Control Plant, Biennial Receiving Water Monitoring Report. August.

Sanitation Districts, 2016. 2014-2015 Joint Water Pollution Control Plant Biennial Receiving Water Monitoring Report. August.

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.

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), 1989. Risk Assessment Guidance for Superfund (RAGS), Volume 1, Human Health Evaluation Manual (Part A), Interim Final. EPA, Office of Emergency and Remedial Response. December.

EPA, 1995. Remedial Design/Remedial Action Handbook, EPA 540/R-95/059. June.

EPA, 2000a. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000). EPA 822/B/00/004. Office of Science and Technology, Washington, DC. October.

EPA, 2000b. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1, Fish Sampling and Analysis, Third Edition. EPA 823-B-00-007. Office of Water, Washington, DC. November.

EPA, 2005. Contaminated Sediment Remediation Guidance for Hazardous Waste Sites, EPA-540-R-05-12. December.

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, 2014. First Five-Year Review Report for Palos Verdes Shelf (OU 5 of the Montrose Chemical Corporation Superfund Site), Los Angeles County, California. September.

EPA. 2015. Statistical Software ProUCL 5.1 for Environmental Applications for Data Sets with and without Nondetect Observations.

https://www.epa.gov/land-research/proucl-software

World Health Organization (WHO), 2006. The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds, as published by Van den Berg, et. al. Toxicological Sciences, 93(2): 223-241. July.

Zeng, E.Y., C.C. Yu, and K. Tran, 1999. In Situ Measurements of Chlorinated Hydrocarbons in the Water Column off the Palos Verdes Peninsula, California, Environmental Science and Technology, *33* (3), pp 392–398.

Zeng, E.Y., D. Tsukada, and D.W. Diehl, 2004. Development of a Solid-Phase Microextraction-Based Method for Sampling of Persistent Chlorinated Hydrocarbons in an Urbanized Coastal Environment, Environmental Science and Technology, *38* (21), pp 5737-5743.

7.0 ACKNOWLEDGEMENTS

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TABLES

Table 2-1 – Test Methods for Sediment (Chemistry)
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Analytical group	*Analyte*	*CAS number*	*Project objective QL[(1)]* (ug/kg)	*Achievable QL[(2)]* (ug/kg)
EPA Method 8270C or 8270SIM: SVOCs by GC/MS				
DDTs	*p,p'*-DDT	50-29-3	5	2.5
	o,p'-DDT	789-02-6	5	2.5
	p,p'-DDE	72-54-8	5	2.5
	o,p'-DDE	53-19-0	5	2.5
	p,p'-DDD	72-55-9	5	2.5
	o,p'-DDD	3424-82-6	5	2.5
	p,p'-DDMU	1022-22-6	5	2.5
	p,p'-DDNU	2642-81-1	5	2.5
PCBs (by congener)	8	34883-43-7	5	2.5
	18	37680-65-2	5	2.5
	28	7012-37-5	5	2.5
	31[(3)]	16606-02-3	5	2.5
	37[(3)]	38444-90-5	5	2.5
	44	41464-39-5	5	2.5
	49[(3)]	41464-40-8	5	2.5
	52	35693-99-3	5	2.5
	66	32598-10-0	5	2.5
	70[(3)]	32598-11-1	5	2.5
	74[(3)]	32690-93-0	5	2.5
	77	32598-13-3	5	2.5
	81	70362-50-4	5	2.5
	87[(3)]	38380-02-8	5	2.5
	99[(3)]	38380-01-7	5	2.5
	101	37680-73-2	5	2.5
	105	32598-14-4	5	2.5
	110[(3)]	38380-03-9	5	2.5
	114	74472-37-0	5	2.5
	118	31508-00-6	5	2.5
	119[(3)]	56558-17-9	5	2.5
	123	65510-44-3	5	2.5
	126	57465-28-8	5	2.5
	128	38380-07-3	5	2.5
	138	35065-28-2	5	2.5
	149[(3)]	38380-04-0	5	2.5
	151[(3)]	52663-63-5	5	2.5
	153	35065-27-1	5	2.5
	156	38380-08-4	5	2.5
	157	69782-90-7	5	2.5

Table 2-1 – Test Methods for Sediment (Chemistry)
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Analytical group	*Analyte*	*CAS number*	*Project objective QL[1]* (ug/kg)	*Achievable QL[2]* (ug/kg)
PCBs (continued)				
	158[3]	74472-42-7	5	2.5
	167	52663-72-6	5	2.5
	168[3]	59291-65-5	5	2.5
	169	32774-16-6	5	2.5
	170	35065-30-6	5	2.5
	177[3]	52663-70-4	5	2.5
	180	35065-29-3	5	2.5
	183[3]	52663-69-1	5	2.5
	187	52663-68-0	5	2.5
	189	39635-32-9	5	2.5
	194[3]	35694-08-7	5	2.5
	195	52663-78-2	5	2.5
	201[3]	40186-71-8	5	2.5
	203[3]	52663-76-0	5	2.5
	206	40186-72-9	5	2.5
	209	2051-24-3	5	2.5
EPA Method 9060				
TOC	Total Organic Carbon	NA	0.1%	0.05%

Abbreviations

CAS - Chemical Abstracts Service
DDTs - dichlorodiphenyltrichloroethane
GC/MS - Gas chromatography/mass spectrometry
MNR - Monitored natural recovery
NA - Not applicable
OU - Operable Unit
PCBs - Polychlorinated biphenyls
QL - Quantitation limit
SIM - Selective ion monitoring
SVOCs - Semivolatile organic compounds
TOC - Total organic carbon
ug/kg - Micrograms per kilogram

Footnotes

(1) Sediment interim cleanup levels of 230 ug/kg DDT @ 1% TOC and 70 ug/kg PCBs @ 1% TOC have been set for the project (EPA, 2009b). However, because the data collected during the remedial action 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.

(3) PCBs are listed by congener. Additional congeners were analyzed for the 2013 sediment program as compared to the 2009 sediment program in order to standardize the congener list to that of the water and fish programs.

Table 2-2 — Common Lists of PCB Congeners
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

PCB congener	***EPA Palos Verdes Shelf expanded list (not including EPA's PSD events)***	***EPA's PSD events at PV Shelf - used by SCCWRP***	***EPA 2009 sediment study***	***Standard list for Sanitation Districts and SCCWRP Bight program***	***MSRP 2002-2004 fish cont. study (regional to SoCal)***	***Dioxin-like congeners (OEHHA, 2011)***	***WHO 2006 advisory (not PV Shelf-specific)***	***WHO 1994 advisory (not PV Shelf-specific)***	***NOAA status & trends 1998***
8	x	x	x		x				x
18	x	x	x	x	x				x
28	x	x	x	x	x				x
31	x				x				
37	x	x		x	x				
44	x	x	x	x	x				x
49	x	x		x	x				
52	x	x	x	x	x				x
66	x	x	x	x	x				x
70	x	x		x	x				
74	x	x		x	x				
77	x	x	x	x	x	x	x	x	x
81	x	x	x	x	x	x	x		
87	x	x		x	x				
99	x	x		x	x				
101	x	x	x	x	x				x
105	x	x	x	x	x	x	x	x	x
110	x	x		x	x				
114	x	x	x	x	x	x	x	x	
118	x	x	x	x	x	x	x	x	x
119	x	x		x	x				
123	x	x	x	x	x	x	x	x	
126	x	x	x	x	x	x	x	x	x
128	x	x	x	x	x				x
138	x	x	x	x	x				x
149	x	x		x	x				
151	x	x		x	x				
153	x	x	x	x	x				x
156	x	x	x	x	x	x	x	x	
157	x	x	x	x	x	x	x	x	
158	x	x	x	x	x				
167	x	x	x	x	x	x	x	x	
168	x	x		x	x				
169	x	x	x	x	x	x	x	x	x
170	x	x	x	x	x	x		x	x
177	x	x		x	x				
180	x	x	x	x	x	x		x	x
183	x	x		x	x				
187	x	x	x	x	x				x
189	x	x	x	x	x	x	x	x	
194	x	x		x	x				
195	x		x		x				x
200		x							
201	x	x		x	x				
203	x				x				
206	x	x	x	x	x				x
209	x	x	x						x
TOTALS	**46**	**44**	**29**	**41**	**45**	**14**	**12**	**13**	**21**

Abbreviations
EPA - United States Environmental Protection Agency
MSRP - Montrose Settlements Restoration Program
NOAA - National Oceanic and Atmospheric Administration
OEHHA - Office of Environmental Health Hazard Assessment (California Environmental Protection Agency)
PCB - polychlorinated biphenyl
POLA/POLB - Port of Los Angeles, Port of Long Beach
PSD - passive sampling device
PV - Palos Verdes
SCCWRP - Southern California Coastal Water Research Project
WHO - World Health Organization

Table 2-3 – Test Methods for Water (High Resolution)
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Target analyte	*Ocean water project decision limit*	*PORL*	*Laboratory EDL*	*Laboratory LOQ*	*Congener co-elutes*
EPA Method 1699: DDTs by HRGC/HRMS					
p,p'-DDT	0.22	0.1	2.5:1 s/n	0.09	NA
o,p'-DDT	NS	0.1	2.5:1 s/n	0.09	NA
p,p'-DDE	0.22	0.1	2.5:1 s/n	0.09	NA
o,p'-DDE	NS	0.1	2.5:1 s/n	0.09	NA
p,p'-DDD	0.31	0.1	2.5:1 s/n	0.09	NA
o,p'-DDD	NS	0.1	2.5:1 s/n	0.09	NA
p,p'-DDMU	NS	1	2.5:1 s/n	0.1	NA
p,p'-DDNU	NS	1	2.5:1 s/n	0.1	NA
EPA Method 1668C: PCBs by HRGC/HRMS (listed by congener number)					
8	NS	0.01	2.5:1 s/n	0.005	
18	NS	0.01	2.5:1 s/n	0.003	30
28	NS	0.01	2.5:1 s/n	0.001	20
31	NS	0.01	2.5:1 s/n	0.001	
37	NS	0.01	2.5:1 s/n	0.001	
44	NS	0.01	2.5:1 s/n	0.002	47/65
49	NS	0.01	2.5:1 s/n	0.001	69
52	NS	0.01	2.5:1 s/n	0.001	
66	NS	0.01	2.5:1 s/n	0.001	
70 & 74	NS	0.01	2.5:1 s/n	0.005	61/76
77	NS	0.01	2.5:1 s/n	0.001	
81	NS	0.01	2.5:1 s/n	0.001	
87 & 119	NS	0.01	2.5:1 s/n	0.005	86/97/109/125
99	NS	0.01	2.5:1 s/n	0.001	83
101	NS	0.01	2.5:1 s/n	0.001	90/113
105	NS	0.01	2.5:1 s/n	0.001	
110	NS	0.01	2.5:1 s/n	0.005	85/115/116/117
114	NS	0.01	2.5:1 s/n	0.001	
118	NS	0.01	2.5:1 s/n	0.001	
123	NS	0.01	2.5:1 s/n	0.001	
126	NS	0.01	2.5:1 s/n	0.001	
128	NS	0.01	2.5:1 s/n	0.001	166
138	NS	0.01	2.5:1 s/n	0.002	129/163
149	NS	0.01	2.5:1 s/n	0.001	147
151	NS	0.01	2.5:1 s/n	0.001	135
153 & 168	NS	0.01	2.5:1 s/n	0.005	
156 & 157	NS	0.01	2.5:1 s/n	0.005	
158	NS	0.01	2.5:1 s/n	0.001	
167	NS	0.01	2.5:1 s/n	0.001	
169	NS	0.01	2.5:1 s/n	0.001	
170	NS	0.01	2.5:1 s/n	0.001	

Table 2-3 – Test Methods for Water (High Resolution)
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Target analyte	***Ocean water project decision limit***	***PORL***	***Laboratory EDL***	***Laboratory LOQ***	***Congener co-elutes***
177	NS	0.01	2.5:1 s/n	0.001	
180	NS	0.01	2.5:1 s/n	0.001	193
183	NS	0.01	2.5:1 s/n	0.001	
187	NS	0.01	2.5:1 s/n	0.001	
189	NS	0.01	2.5:1 s/n	0.001	
194	NS	0.01	2.5:1 s/n	0.001	
195	NS	0.01	2.5:1 s/n	0.001	
201	NS	0.01	2.5:1 s/n	0.001	
203	NS	0.01	2.5:1 s/n	0.001	
206	NS	0.01	2.5:1 s/n	0.001	
209	NS	0.01	2.5:1 s/n	0.005	

Abbreviations

AWQC – Ambient water quality criteria
CAS – Chemical Abstracts Society
EDL – Estimated detection limit
HRGC – High resolution gas chromatography
HRMS – High resolution mass spectrometry
LOQ – Limit of quantitation
NA – Not applicable
NS – No standard available
PCBs – Polychlorinated biphenyls
PORL – Project objective reporting limit
s/n – Signal-to-noise ratio

Notes

1. Concentration units (for project decision limits, LOQs, and PORLs) are nanograms per liter (ng/L).
2. Explanations for EDLs, LOQs, and PORLs were presented in the *Final Quality Assurance Project Plan – Water Sampling, Remedial Action – Monitored Natural Recovery Component, Palos Verdes Shelf, Los Angeles County, California* (Gilbane Federal, 2014).
3. PCB congeners 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189 are dioxin-like congeners (WHO, 2006).

Table 2-4 –Test Methods for Water (PSDs)
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Analytical group	*Analyte*	*CAS number*	*Project objective QL[(1)]* (ng/L)	*SPME Achievable QL[(2)]* (ng/L)	*PED Achievable QL[(2,3)]* (ng/L)
SCCWRP SOPs Chapter 27 and 35 – GC/MS SIM					
DDTs	*p,p'*-DDT	50-29-3	NE	0.20	--
	o,p'-DDT	789-02-6	NE	0.074	--
	p,p'-DDE	72-54-8	NE	0.022	0.0068
	o,p'-DDE	53-19-0	NE	0.011	0.0063
	p,p'-DDD	72-55-9	NE	0.14	0.013
	o,p'-DDD	3424-82-6	NE	0.038	0.0081
	p,p'-DDMU	1022-22-6	NE	0.022	0.013
	p,p'-DDNU	2642-81-1	NE	0.019	0.022
PCBs (by congener)	8	34883-43-7	NE	0.11	0.0057
	18	37680-65-2	NE	0.037	0.0053
	28	7012-37-5	NE	0.027	0.0016
	37	38444-90-5	NE	0.035	0.0012
	44	41464-39-5	NE	0.018	0.0020
	49	41464-40-8	NE	0.014	0.0014
	52	35693-99-3	NE	0.015	0.0014
	66	32598-10-0	NE	0.012	0.00054
	70	32598-11-1	NE	0.012	0.00054
	74	32690-93-0	NE	0.013	0.00055
	77	32598-13-3	NE	0.014	0.00055
	81	70362-50-4	NE	0.014	0.00046
	87	38380-02-8	NE	0.016	0.0011
	99	38380-01-7	NE	0.014	0.00073
	101	37680-73-2	NE	0.012	0.00073
	105	32598-14-4	NE	0.0094	0.00047
	110	38380-03-9	NE	0.0099	0.00058
	114	74472-37-0	NE	0.011	0.00040
	118	31508-00-6	NE	0.011	0.00035
	119	56558-17-9	NE	0.011	0.00040
	123	65510-44-3	NE	0.011	0.00034
	126	57465-28-8	NE	0.057	0.00031
	128	38380-07-3	NE	0.022	0.0014
	138	35065-28-2	NE	0.020	0.00030
	149	38380-04-0	NE	0.016	0.0013
	151	52663-63-5	NE	0.0095	0.0013
	153/168	35065-27-1/59291-65-5	NE	0.011	0.00066
	156	38380-08-4	NE	0.080	0.00041
	157	69782-90-7	NE	0.025	0.00044
	158	74472-42-7	NE	0.015	0.00050
	167	52663-72-6	NE	0.026	0.00031

Table 2-4 –Test Methods for Water (PSDs)
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Analytical group	*Analyte*	*CAS number*	*Project objective QL*[(1)] **(ng/L)**	*SPME Achievable QL*[(2)] **(ng/L)**	*PED Achievable QL*[(2,3)] **(ng/L)**
PCBs (continued)	169	32774-16-6	NE	0.038	0.00022
	170	35065-30-6	NE	0.091	0.00056
	177	52663-70-4	NE	0.058	0.00091
	180	35065-29-3	NE	0.069	0.00047
	183	52663-69-1	NE	0.052	0.00064
	187	52663-68-0	NE	0.013	0.00064
	189	39635-32-9	NE	0.082	0.00013
	194	35694-08-7	NE	0.17	0.00026
	200	52663-73-7	NE	0.022	0.00071
	201	40186-71-8	NE	0.20	0.00049
	206	40186-72-9	NE	0.23	0.00015
	209	2051-24-3	NE	0.0068	0.00017

Abbreviations

CAS - Chemical Abstracts Service
DDTs - dichlorodiphenyltrichloroethane and its byproducts
GC/MS - gas chromatography/mass spectrometry
MNR - monitored natural recovery
NA - not applicable
NE - not established
ng/L - nanograms per liter
OU - Operable Unit
PCBs - polychlorinated biphenyls
PED - polyethylene device
PSD - passive sampling device
QL - quantitation limit
SCCWRP - Southern California Coastal Water Research Project
SIM - selective ion monitoring
SOP - standard operating procedure
SPME - solid-phase microextraction

Footnotes

(1) The PSD QAPP did not specify project quantitation limits for the analytical laboratory.

(2) Achievable QLs are the laboratory reporting limits for a specific analytical method.

(3) A conservative QL is presented using the maximum sample-specific reporting limit calculated for PEDs based on the observed fraction of equilibrium between sampler and water at a representative station.

Table 2-5 - Planned Fish Collections
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Collection area	*Number of barred sand bass*	*Number of white croaker*
Zone 1	30	30
Zone 2	10	30
Zone 3	30	30
Breakwater Zone	30	30
Huntington Flats	30	0
Redondo Flats	30	30
Ventura Flats	0	30
Total	160	180

Table 2-6 – Test Methods for Fish
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Target Analyte	***Fish tissue project decision limit***	***PORL***	***Laboratory EDL***	***Laboratory LOQ***	***Congener co-elutes***
EPA Method 1699: DDTs by HRGC/HRMS					
p,p'-DDT	625	100	2.5:1 s/n	40	NA
o,p'-DDT	625	100	2.5:1 s/n	20	NA
p,p'-DDE	625	100	2.5:1 s/n	40	NA
o,p'-DDE	625	100	2.5:1 s/n	40	NA
p,p'-DDD	625	100	2.5:1 s/n	20	NA
o,p'-DDD	625	100	2.5:1 s/n	20	NA
p,p'-DDMU	625	200	2.5:1 s/n	200	NA
p,p'-DDNU	625	100	2.5:1 s/n	40	NA
EPA Method 1668C: PCBs by HRGC/HRMS (listed by congener number)					
8	NS	2.5	2.5:1 s/n	1.0	5
18	NS	2.5	2.5:1 s/n	0.5	
28	NS	2.5	2.5:1 s/n	0.5	
31	NS	2.5	2.5:1 s/n	0.5	
37	NS	2.5	2.5:1 s/n	0.5	
44	NS	2.5	2.5:1 s/n	0.5	
49	NS	2.5	2.5:1 s/n	1.0	43
52	NS	2.5	2.5:1 s/n	1.0	69
66	NS	2.5	2.5:1 s/n	1.0	76
70	NS	2.5	2.5:1 s/n	1.0	61
74	NS	2.5	2.5:1 s/n	0.5	
77	NS	2.5	2.5:1 s/n	0.5	
81	NS	2.5	2.5:1 s/n	0.5	
87	NS	2.5	2.5:1 s/n	1.5	117/125
99	NS	2.5	2.5:1 s/n	0.5	
101	NS	2.5	2.5:1 s/n	1.0	90
105	NS	2.5	2.5:1 s/n	0.5	
110	NS	2.5	2.5:1 s/n	0.5	
114	NS	2.5	2.5:1 s/n	0.5	
118	NS	2.5	2.5:1 s/n	1.0	106
119	NS	2.5	2.5:1 s/n	0.5	
123	NS	2.5	2.5:1 s/n	0.5	
126	NS	2.5	2.5:1 s/n	0.5	
128	NS	2.5	2.5:1 s/n	1.0	162
138	NS	2.5	2.5:1 s/n	1.5	163/164
149	NS	2.5	2.5:1 s/n	1.0	139
151	NS	2.5	2.5:1 s/n	0.5	
153	NS	2.5	2.5:1 s/n	0.5	
156	NS	2.5	2.5:1 s/n	0.5	
157	NS	2.5	2.5:1 s/n	0.5	
158	NS	2.5	2.5:1 s/n	1.0	160
167	NS	2.5	2.5:1 s/n	0.5	
168	NS	2.5	2.5:1 s/n	0.5	
169	NS	2.5	2.5:1 s/n	0.5	
170	NS	2.5	2.5:1 s/n	0.5	
177	NS	2.5	2.5:1 s/n	0.5	
180	NS	2.5	2.5:1 s/n	0.5	
183	NS	2.5	2.5:1 s/n	0.5	
187	NS	2.5	2.5:1 s/n	1.0	182

Table 2-6 – Test Methods for Fish
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Target Analyte	***Fish tissue project decision limit***	***PORL***	***Laboratory EDL***	***Laboratory LOQ***	***Congener co-elutes***
189	NS	2.5	2.5:1 s/n	0.5	
194	NS	2.5	2.5:1 s/n	0.5	
195	NS	2.5	2.5:1 s/n	0.5	
201	NS	2.5	2.5:1 s/n	0.5	
203	NS	2.5	2.5:1 s/n	1.0	196
206	NS	2.5	2.5:1 s/n	0.5	
209	NS	2.5	2.5:1 s/n	0.5	
Percent Lipids by Bligh-Dyer Extraction and Gravimetry					
Lipids	NS	0.01%	0.001g	0.002g	NA

Abbreviations

AWQC – Ambient water quality criteria
CAS – Chemical Abstracts Society
EDL – Estimated detection limit
HRGC – High resolution gas chromatography
HRMS – High resolution mass spectrometry
LOQ – Limit of quantitation
NA – Not applicable
NS – No standard available
PCBs – Polychlorinated biphenyls
PORL – Project objective reporting limit
s/n – Signal-to-noise ratio

Notes

1. Concentration units (for project decision limits, LOQs, and PORLs) are picograms per gram (pg/g), unless otherwise noted.
2. Explanations for EDLs, LOQs, and PORLs were presented in the *Final Quality Assurance Project Plan, Fish Sampling Program, Remedial Action – Monitored Natural Recovery Component, Palos Verdes Shelf, Los Angeles County, California* (Gilbane Federal, 2016).
3. PCB congeners 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189 are dioxin-like congeners (WHO, 2006).

Table 3-1 – Coordinates of Shelf-Wide Sediment Cores
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Location name	***Replicate collected?***	***N/E 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 3-2 – Coordinates of Outfall Area Sediment Cores
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Location name	***Replicate collected?***	***N/E 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
OA26	No	33^{o} 42.10’/118^{o} 20.47’	60
OA27	No	33^{o} 41.91’/118^{o} 20.78’	145
OA28	No	33^{o} 41.87’/118^{o} 20.37’	70
OA29	No	33^{o} 41.72’/118^{o} 20.49’	145
OA30	No	33^{o} 41.98’/118^{o} 19.87’	50
OA31	No	33^{o} 41.84’/118^{o} 19.96’	60
OA32	No	33^{o} 41.70’/118^{o} 20.04’	70
OA33	No	33^{o} 41.54’/118^{o} 19.36’	60
OA34	No	33^{o} 41.37’/118^{o} 19.49’	70
OA35	No	33^{o} 41.32’/118^{o} 19.59’	80

Notes

1. Coordinates are latitude/longitude shown in degrees-decimal minutes.
2. The basis for selecting the planned cores was presented in the sediment Field Sampling Plan (ITSI Gilbane, 2014).

Table 3-3 — Sediment Core Lengths and Samples Generated
First MNR Report
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*	*Number of samples generated*
Transect 1				
BA1B	150	60	29	16
BA1C	60	48	24	14
BA1DC	40	31	15	9
Transect 2				
BA2B	150	35	16	10
BA2BR	150	22	10	7
BA2C	60	60	30	17
BA2DC	40	46	23	13
Transect 3				
BA3B	150	37	17	10
BA3C	60	67	33	17
BA3DC	40	59	29	16
Transect 4				
BA4B	150	56	28	16
BA4C	60	63	30	17
BA4CR	60	63	31	17
BA4DC	40	86	43	23
Transect 5				
BA5B	150	66	33	18
BA5BR	150	68	34	19
BA5C	60	79	41	22
BA5DC	40	81	40	22
Transect 6				
BA6B	150	79	39	21
BA6BC	100	33	16	10
BA6C	60	79	40	21
BA6DC	40	56	27	15
Transect 7				
BA7B	150	50	25	14
BA7BC	100	24	12	8
OA01	70	52	26	15
BA7C	60	68	34	19
OA02	50	79	39	21
BA7DC	40	61	30	17
Transect 7.5				
OA03	80	60	30	17
OA04	70	57	28	16
OA05	60	85	42	23
OA05R	60	85	43	23
OA06	50	77	38	21
OA07	70	58	29	16
OA07R	70	45	22	13
OA08	50	81	40	22
OA09	40	61	30	17
OA26	60	72	36	20
OA27	150	29	14	9
Transect 7.75				
OA28	70	57	23	13
OA29	150	56	28	16
Transect 8				
BA8B	150	61	30	17
BA8BC	100	37	18	11
OA10	70	53	26	15
OA10R	70	44	22	13

Table 3-3 — Sediment Core Lengths and Samples Generated
First MNR Report
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***	***Number of samples generated***
BA8C	60	79	40	22
OA11	50	83	42	22
OA11R	50	77	39	21
BA8DC	40	60	30	17
Transect 8.5				
OA12	70	41	21	12
OA12R	70	39	20	11
OA13	60	54	27	15
OA14	50	67	34	18
OA15	80	51	25	14
OA16	70	42	22	12
OA16R	70	49	24	14
OA17	60	35	17	10
OA30	50	71	35	19
OA31	60	66	33	18
OA32	70	51	26	14
Transect 8.75				
OA33	60	32	15	9
OA34	70	36	19	10
OA35	80	56	28	16
Transect 9				
BA9B	150	45	22	13
BA9BC	100	33	18	10
OA18	90	45	23	13
OA19	75	42	21	12
BA9C	60	32	16	10
BA9DC	40	45	22	13
OA20	40	56	27	15
Transect 9.25				
OA21	80	18	8	6
OA22	60	38	18	11
OA22R	60	43	20	12
OA23	50	51	25	14
Transect 9.5				
OA24	70	27	11	7
OA25	50	41	18	11
Transect 10				
BA10B	150	31	15	9
BA10C	60	25	12	8
BA10DC	40	36	18	11
GRAND TOTAL	**-**	**-**	**2,084**	**1,175**

Abbreviations
cm - Centimeters
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.

Table 3-4 – Grain Size and TOC for Sediment (60-m Isobath)
First MNR Report
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 (down-current) of outfalls						
BA1C	60	48	43	43	14	2.8
BA2C	60	60	57	29	13	3.1
BA3C	60	67	48	39	13	3.5
BA4C	60	63	29	57	14	2.4
BA4CR	60	63	29	56	15	2.7
BA5C	60	79	24	61	16	3.6
BA6C	60	79	32	50	18	3.6
BA7C	60	68	43	41	15	3.2
OA05	60	85	28	52	20	4.0
OA05R	60	85	28	50	22	4.7
OA26	60	72	30	52	18	4.3
		Average	**36**	**48**	**16**	**3.4**
Outfall vicinity						
BA8C	60	79	49	29	19	8.8
OA13	60	54	33	53	15	2.6
OA17	60	35	35	52	14	1.5
OA31	60	66	29	56	14	2.4
		Average	**36**	**48**	**16**	**3.8**
Southeast (up-current) of outfalls						
OA33	60	32	48	42	9.7	0.85
BA9C	60	32	46	41	13	1.5
OA22	60	38	48	38	14	1.4
OA22R	60	43	50	38	12	1.3
BA10C	60	25	58	28	12	0.71
		Average	**50**	**37**	**12**	**1.2**

Abbreviations
cm - Centimeters
m - Meters
TOC - Total organic carbon

Table 3-5 — DDTs in 0-8-cm Sediment Bed-Depth Interval
First MNR Report
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* **(ug/kg)**	*Average Total DDTs (OC normalized)* **(ug/kg OC)**	*Average Total DDT Compounds* **(ug/kg)**	*Average Total DDT Compounds (OC normalized)* **(ug/kg OC)**
Shelf-wide Cores					
BA1B	150	920	56,000	1,200	73,000
BA1C	150	1,300	44,000	1,800	62,000
BA1DC	150	390	30,000	540	42,000
BA2B	150	1,200	48,000	1,300	55,000
BA2BR	150	1,100	60,000	1,500	78,000
BA2C	150	1,100	37,000	1,600	56,000
BA2DC	150	200	3,300	270	4,400
BA3B	150	2,900	150,000	3,900	210,000
BA3C	150	1,100	43,000	1,500	59,000
BA3DC	150	310	6,500	480	10,000
BA4B	150	5,300	180,000	8,500	290,000
BA4C	150	1,700	88,000	2,500	130,000
BA4CR	100	1,800	86,000	2,500	120,000
BA4DC	100	920	41,000	1,400	62,000
BA5B	100	10,000	190,000	16,000	300,000
BA5BR	100	11,000	170,000	17,000	270,000
BA5C	60	2,800	140,000	3,700	180,000
BA5DC	60	630	34,000	890	49,000
BA6B	60	10,000	200,000	20,000	380,000
BA6BC	60	7,100	150,000	17,000	340,000
BA6C	60	2,900	150,000	3,600	180,000
BA6DC	60	1,400	75,000	1,600	92,000
BA7B	60	5,500	160,000	11,000	310,000
BA7BC	60	720	50,000	910	63,000

Table 3-5 — DDTs in 0-8-cm Sediment Bed-Depth Interval
First MNR Report
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* (ug/kg)**	***Average Total DDTs (OC normalized)* (ug/kg OC)**	***Average Total DDT Compounds* (ug/kg)**	***Average Total DDT Compounds (OC normalized)* (ug/kg OC)**
BA7C	60	1,300	87,000	1,600	100,000
BA7DC	60	560	44,000	660	52,000
BA8B	60	9,100	180,000	23,000	440,000
BA8BC	40	1,400	34,000	2,100	51,000
BA8C	40	76,000	1,400,000	81,000	1,500,000
BA8DC	40	1,100	100,000	1,300	120,000
BA9B	40	3,200	130,000	4,500	180,000
BA9BC	40	2,100	86,000	3,000	120,000
BA9C	40	2,400	170,000	2,900	200,000
BA9DC	40	680	48,000	820	58,000
BA10B	40	710	55,000	830	65,000
BA10C	40	300	37,000	340	42,000
BA10DC	40	300	26,000	350	31,000
Outfall area cores					
OA01	70	2,500	120,000	3,000	140,000
OA02	50	2,400	120,000	3,100	160,000
OA03	50	4,600	130,000	5,500	160,000
OA04	70	4,300	140,000	4,900	160,000
OA05	60	3,300	130,000	3,900	150,000
OA05R	60	4,700	200,000	5,700	240,000
OA06	50	5,800	270,000	7,300	350,000
OA07	70	12,000	330,000	19,000	510,000
OA07R	70	15,000	340,000	25,000	560,000
OA08	50	9,200	380,000	12,000	470,000
OA09	40	1,300	91,000	1,500	100,000

Table 3-5 — DDTs in 0-8-cm Sediment Bed-Depth Interval
First MNR Report
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* (ug/kg)	*Average Total DDTs (OC normalized)* (ug/kg OC)	*Average Total DDT Compounds* (ug/kg)	*Average Total DDT Compounds (OC normalized)* (ug/kg OC)
OA10	70	8,100	220,000	12,000	310,000
OA10R	70	8,500	300,000	12,000	400,000
OA11	50	6,900	320,000	8,500	390,000
OA11R	50	7,500	290,000	9,300	370,000
OA12	70	3,200	160,000	4,500	220,000
OA12R	70	2,500	150,000	3,700	220,000
OA13	60	2,000	120,000	2,400	150,000
OA14	50	1,900	120,000	2,400	150,000
OA15	80	3,500	180,000	5,200	270,000
OA16	70	2,100	110,000	3,000	150,000
OA16R	70	3,900	220,000	5,500	310,000
OA17	60	2,500	160,000	3,600	220,000
OA18	90	2,400	98,000	3,200	130,000
OA19	80	1,900	140,000	3,000	210,000
OA20	40	580	37,000	660	42,000
OA21	80	2,500	150,000	3,100	190,000
OA22	60	1,500	110,000	2,100	160,000
OA22R	60	700	56,000	900	72,000
OA23	50	820	64,000	1,000	79,000
OA24	70	2,700	170,000	3,900	230,000
OA25	50	400	42,000	490	52,000
OA26	60	9,300	360,000	12,000	460,000
OA27	150	3,700	170,000	5,700	270,000
OA28	70	8,700	190,000	11,000	240,000
OA29	150	7,200	150,000	17,000	350,000
OA30	50	3,100	170,000	3,800	210,000
OA31	60	3,100	170,000	3,600	200,000

Table 3-5 — DDTs in 0-8-cm Sediment Bed-Depth Interval
First MNR Report
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* (ug/kg)**	***Average Total DDTs (OC normalized)* (ug/kg OC)**	***Average Total DDT Compounds* (ug/kg)**	***Average Total DDT Compounds (OC normalized)* (ug/kg OC)**
OA32	70	4,300	210,000	5,500	260,000
OA33	60	170	21,000	230	28,000
OA34	70	9,700	320,000	15,000	490,000
OA35	80	7,900	300,000	14,000	520,000

Abbreviations
cm - Centimeters
m - Meters
OC - Organic carbon
ug/kg - Micrograms per kilogram

Notes
1. "Total DDTs" consists of both *o,p′*- and *p,p′*- isomers of DDD, DDE, and DDT.
2. "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 3-6 — PCBs in 0-8-cm Sediment Bed-Depth Interval
First MNR Report
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 - short list* (ug/kg)	*Average Total PCBs (OC normalized) - short list* (ug/kg OC)	*Average Total PCBs - expanded list* (ug/kg)	*Average Total PCBs (OC normalized) - expanded list* (ug/kg OC)
Shelf-wide cores					
BA1B	150	69	4,200	140	8,300
BA1C	150	97	3,300	190	6,700
BA1DC	150	28	2,200	57	4,400
BA2B	150	68	2,900	140	5,700
BA2BR	150	70	3,600	140	7,200
BA2C	150	110	4,000	230	7,900
BA2DC	150	15	240	30	490
BA3B	150	230	12,000	450	24,000
BA3C	150	88	3,500	170	6,800
BA3DC	150	27	570	54	1,200
BA4B	150	560	19,000	1,100	39,000
BA4C	150	100	5,400	210	11,000
BA4CR	100	120	5,700	240	11,000
BA4DC	100	58	2,500	110	5,100
BA5B	100	1,000	18,000	2,100	37,000
BA5BR	100	780	12,000	1,500	24,000
BA5C	60	120	5,800	250	12,000
BA5DC	60	60	3,300	120	6,600
BA6B	60	1,700	31,000	3,300	61,000
BA6BC	60	620	13,000	1,200	26,000
BA6C	60	140	7,100	280	14,000
BA6DC	60	30	1,700	60	3,400
BA7B	60	850	25,000	1,700	51,000
BA7BC	60	49	3,200	95	6,300
BA7C	60	72	4,800	140	9,500
BA7DC	60	30	2,400	61	4,800
BA8B	60	1,700	33,000	3,400	67,000
BA8BC	40	180	4,300	350	8,700
BA8C	40	3,200	73,000	6,200	140,000

Table 3-6 — PCBs in 0-8-cm Sediment Bed-Depth Interval
First MNR Report
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 - short list* (ug/kg)	*Average Total PCBs (OC normalized) - short list* (ug/kg OC)	*Average Total PCBs - expanded list* (ug/kg)	*Average Total PCBs (OC normalized) - expanded list* (ug/kg OC)
BA8DC	40	60	5,300	120	11,000
BA9B	40	290	12,000	580	23,000
BA9BC	40	220	9,000	430	18,000
BA9C	40	54	3,900	110	7,700
BA9DC	40	38	2,700	75	5,300
BA10B	40	41	3,200	93	7,300
BA10C	40	9	1,100	20	2,500
BA10DC	40	18	1,600	40	3,500
Outfall area cores					
OA01	70	130	6,200	260	12,000
OA02	50	140	7,000	280	14,000
OA03	50	340	9,700	670	19,000
OA04	70	370	12,000	740	25,000
OA05	60	180	6,900	360	14,000
OA05R	60	280	12,000	560	24,000
OA06	50	370	18,000	750	36,000
OA07	70	1,100	28,000	2,100	55,000
OA07R	70	1,100	25,000	2,300	50,000
OA08	50	470	19,000	940	38,000
OA09	40	37	2,400	75	5,000
OA10	70	600	15,000	1,200	30,000
OA10R	70	440	16,000	890	32,000
OA11	50	360	17,000	720	34,000
OA11R	50	380	15,000	750	29,000
OA12	70	270	13,000	550	27,000
OA12R	70	210	13,000	430	26,000
OA13	60	130	7,600	250	15,000

Table 3-6 — PCBs in 0-8-cm Sediment Bed-Depth Interval
First MNR Report
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 - short list* (ug/kg)	*Average Total PCBs (OC normalized) - short list* (ug/kg OC)	*Average Total PCBs - expanded list* (ug/kg)	*Average Total PCBs (OC normalized) - expanded list* (ug/kg OC)
OA14	50	92	5,700	180	11,000
OA15	80	240	12,000	480	25,000
OA16	70	180	9,100	370	18,000
OA16R	70	230	13,000	470	26,000
OA17	60	150	8,400	320	17,000
OA18	90	250	10,000	500	20,000
OA19	80	140	9,600	270	19,000
OA20	40	30	2,000	63	4,100
OA21	80	190	12,000	380	23,000
OA22	60	110	8,000	220	16,000
OA22R	60	62	4,900	120	9,700
OA23	50	48	3,700	96	7,400
OA24	70	260	16,000	530	31,000
OA25	50	23	2,400	46	4,900
OA26	60	650	25,000	1,300	50,000
OA27	150	290	15,000	590	31,000
OA28	70	460	10,000	930	20,000
OA29	150	1,300	26,000	2,500	52,000
OA30	50	160	8,700	310	17,000
OA31	60	110	6,200	220	12,000
OA32	70	220	11,000	440	22,000
OA33	60	12	1,500	25	3,000
OA34	70	920	30,000	1,900	60,000
OA35	80	800	31,000	1,600	62,000

Abbreviations
cm - Centimeters
m - Meters
OC - Organic carbon
ug/kg - Micrograms per kilogram

Table 3-7 - Average Concentrations of COCs in Sediment
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

	Total DDTs	***Total DDT Compounds***	***Total PCBs - short list***	***Total PCBs - expanded list***
2009 Data Set				
Full model (baseline and outfall area)				
Total bed	1,600	2,300	120	*NA*
0-8 cm interval	1,300	1,600	86	*NA*
Outfall area				
Total bed	2,800	3,600	160	*NA*
0-8 cm interval	1,900	2,400	110	*NA*
2013 Data Set				
Full model (shelf-wide and outfall area)				
Total bed	3,300	4,700	200	400
0-8 cm interval	1,800	2,500	120	240
Outfall area				
Total bed	5,600	7,400	300	600
0-8 cm interval	2,500	3,300	160	320
NORMALIZED FOR ORGANIC CARBON				
2009 Data Set				
Full model (baseline and outfall area)				
Total bed	58,000	85,000	4,500 (410)	NA
0-8 cm interval	56,000	71,000	3,000 (230)	NA
Outfall area				
Total bed	98,000	130,000	6,500 (570)	NA
0-8 cm interval	83,000	100,000	4,700 (300)	NA
2013 Data Set				
Full model (shelf-wide and outfall area)				
Total bed	98,000	140,000	6,500	13,000
0-8 cm interval	77,000	110,000	5,000	10,000
Outfall area				
Total bed	160,000	210,000	9,900	20,000
0-8 cm interval	120,000	150,000	7,100	14,000

Abbreviations
cm - Centimeter
COCs - Chemicals of concern
NA - Not available
OC - Organic carbon

Notes
1. All values are in micrograms per kilogram (parts per billion).
2. For the Total PCBs OC normalized (short list) from the 2009 sediment data set, the values in parentheses were previously published (ITSI Gilbane, 2013b), and are believed to be erroneous. There may have been errors in the computational formulas used to prepare the input to the MVS model. Values without parentheses are based on rigorous quality control checks performed in winter 2016-2017, and are believed to be the best estimates of average Total PCBs OC normalized concentrations for the 2009 sediment data set.

Table 3-8 - Estimates of Mass of COCs in Sediment
First MNR Report
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 - short list*	*Total PCBs - expanded list*
2009 Data Set												
Full model (baseline and outfall area)												
Total bed	290	1,900	120	1,300	9,700	530	14,000	5,200	940	20,000	1,000	NA
0-8 cm interval	36	210	16	190	1,200	63	1,700	410	71	2,200	110	NA
Outfall area												
Total bed	150	930	33	920	5,000	310	7,300	1,200	330	8,800	460	NA
0-8 cm interval	19	110	5.8	140	600	37	910	210	33	1,200	58	NA
2013 Data Set												
Full model (shelf-wide and outfall area)												
Total bed	730	6,100	100	2,700	30,000	2,600	42,000	18,000	1,300	61,000	2,900	5,900
0-8 cm interval	64	470	10	280	2,500	250	3,600	1,300	110	5,000	280	570
Outfall area												
Total bed	420	3,300	67	1,800	17,000	1,900	24,000	7,200	470	32,000	1,500	3,000
0-8 cm interval	31	210	7	170	1,100	180	1,700	540	39	2,300	140	270

Abbreviations

cm - Centimeter
COCs - Chemicals of concern
NA - Not available
PCBs - Polychlorinated biphenyls

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 (ug/kg) was used.
3. The baseline/shelf-wide modeled area was 30 square kilometers (km2). The outfall modeled area was 11 km2.
4. The volume of the baseline/shelf-wide modeled grid was 15 million cubic meters (m3).
5. The volume of the 0-8 cm interval as modeled was 2.3 million m3.

Table 3-9 – Collection Data – High Resolution Grab Water Samples
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Grid ID	*Latitude*	*Longitude*	*Sample ID*	*Sample type*	*Depth* (m)	*Date*	*Time*
BA1B	33° 44.975' N	118° 26.818' W	BA1B-WO5-0915-1	Ocean water	5	9/23/15	1137
			BA1B-WO75-0915-1	Ocean water	75	9/23/15	1112
			BA1B-WO145-0915-1	Ocean water	147	9/23/15	1127
BA1C	33° 45.440' N	118° 26.460' W	BA1C-WO5-0915-1	Ocean water	5	9/16/15	1103
			BA1C-WO30-0915-1	Ocean water	30	9/16/15	1110
			BA1C-WO55-0915-1	Ocean water	57	9/16/15	1123
			BA1C-WO60-0915-1	Ocean water	59	9/16/15	1134
BA1DC	33° 45.758' N	118° 26.226' W	BA1DC-WO5-0915-1	Ocean water	5	9/23/15	1148
			BA1DC-WO5-0915-2	Replicate	5	9/23/15	1153
			BA1DC-WO20-0915-1	Ocean water	20	9/16/15	1207
			BA1DC-WO35-0915-1	Ocean water	35	9/16/15	1215
BA2B	33° 43.940' N	118° 25.561' W	BA2B-WO5-0915-1	Ocean water	5	9/16/15	1451
			BA2B-WO75-0915-1	Ocean water	75	9/16/15	1501
			BA2B-WO145-0915-1	Ocean water	145	9/23/15	1228
BA2C	33° 44.267' N	118° 25.393' W	BA2C-WO5-0915-1	Ocean water	5	9/23/15	1243
			BA2C-WO30-0915-1	Ocean water	30	9/16/15	1354
			BA2C-WO55-0915-1	Ocean water	55	9/16/15	1406
BA2DC	33° 44.386' N	118° 25.329' W	BA2DC-WO5-0915-1	Ocean water	5	9/16/15	1243
			BA2DC-WO20-0915-1	Ocean water	20	9/16/15	1254
			BA2DC-WO35-0915-1	Ocean water	39	9/16/15	1327
BA3B	33° 43.424' N	118° 24.454' W	BA3B-WO5-0915-1	Ocean water	5	9/23/15	1322
			BA3B-WO80-0915-1	Ocean water	75	9/23/15	1300
			BA3B-WO145-0915-1	Ocean water	153	9/23/15	1312
BA3C	33° 43.800' N	118° 24.150' W	BA3C-WO5-0915-1	Ocean water	5	9/16/15	1658
			BA3C-WO5-1115-1	Time replicate	5	11/30/15	1250
			BA3C-WO30-0915-1	Ocean water	30	9/16/15	1708
			BA3C-WO55-0915-1	Ocean water	55	9/16/15	1720
			BA3C-WO58-0915-1	Ocean water	58	9/16/15	1729
BA3DC	33° 43.950' N	118° 24.043' W	BA3DC-WO5-0915-1	Ocean water	5	9/16/15	1633
			BA3DC-WO20-0915-1	Ocean water	20	9/16/15	1641
			BA3DC-WO35-0915-1	Ocean water	38	9/16/15	1650
BA4B	33° 43.002' N	118° 23.245' W	BA4B-WO5-0915-1	Ocean water	5	9/17/15	1719
			BA4B-WO75-0915-1	Ocean water	75	9/17/15	1804
			BA4B-WO145-0915-1	Ocean water	141	9/17/15	1744

Table 3-9 – Collection Data – High Resolution Grab Water Samples
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Grid ID	*Latitude*	*Longitude*	*Sample ID*	*Sample type*	*Depth* (m)	*Date*	*Time*
BA4C	33° 43.400' N	118° 23.080' W	BA4C-WO5-0915-1	Ocean water	5	9/17/15	1817
			BA4C-WO30-0915-1	Ocean water	30	9/17/15	1828
			BA4C-WO55-0915-1	Ocean water	55	9/17/15	1851
			BA4C-WO58-0915-1	Ocean water	58	9/17/15	1903
BA4DC	33° 43.756' N	118° 22.909' W	BA4DC-WO5-0915-1	Ocean water	5	9/23/15	1352
			BA4DC-WO20-0915-1	Ocean water	20	9/23/15	1339
			BA4DC-WO35-0915-1	Ocean water	36	9/23/15	1346
BA5B	33° 42.541' N	118° 22.083' W	BA5B-WO5-0915-1	Ocean water	5	9/22/15	1032
			BA5B-WO75-0915-1	Ocean water	75	9/22/15	1042
			BA5B-WO145-0915-1	Ocean water	145	9/22/15	1058
BA5C	33° 42.880' N	118° 21.960' W	BA5C-WO5-0915-1	Ocean water	5	9/22/15	1114
			BA5C-WO30-0915-1	Ocean water	30	9/22/15	1159
			BA5C-WO55-0915-1	Ocean water	55	9/22/15	1149
			BA5C-WO58-0915-1	Ocean water	59	9/22/15	1123
			BA5C-WO58-0915-2	Replicate	59	9/22/15	1134
BA5DC	33° 43.230' N	118° 21.830' W	BA5DC-WO5-0915-1	Ocean water	5	9/22/15	1307
			BA5DC-WO20-0915-1	Ocean water	20	9/22/15	1300
			BA5DC-WO35-0915-1	Ocean water	35	9/22/15	1251
			BA5DC-WO38-0915-1	Ocean water	38	9/22/15	1231
			BA5DC-WO38-0915-2	Replicate	38	9/22/15	1242
BA6B	33° 42.182' N	118° 21.359' W	BA6B-WO5-0915-1	Ocean water	5	9/22/15	1408
			BA6B-WO75-0915-1	Ocean water	75	9/22/15	1357
			BA6B-WO145-0915-1	Ocean water	130	9/22/15	1337
BA6BC	33° 42.270' N	118° 21.387' W	BA6BC-WO5-0915-1	Ocean water	5	9/22/15	1443
			BA6BC-WO50-0915-1	Ocean water	50	9/22/15	1435
			BA6BC-WO95-0915-1	Ocean water	88	9/22/15	1424
BA6C	33° 42.471' N	118° 21.242' W	BA6C-WO5-0915-1	Ocean water	5	9/22/15	1523
			BA6C-WO30-0915-1	Ocean water	30	9/22/15	1512
			BA6C-WO55-0915-1	Ocean water	54	9/24/15	1118
BA6DC	33° 42.757' N	118° 21.049' W	BA6DC-WO5-0915-1	Ocean water	5	9/22/15	1556
			BA6DC-WO20-1115-1	Ocean water	20	11/30/15	1122
			BA6DC-WO35-0915-1	Ocean water	35	9/22/15	1539
BA7B	33° 42.049' N	118° 21.086' W	BA7B-WO5-0915-1	Ocean water	5	9/24/15	1012
			BA7B-WO75-0915-1	Ocean water	75	9/24/15	1037
			BA7B-WO145-0915-1	Ocean water	140	9/24/15	1023

Table 3-9 – Collection Data – High Resolution Grab Water Samples
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Grid ID	*Latitude*	*Longitude*	*Sample ID*	*Sample type*	*Depth* (m)	*Date*	*Time*
BA7BC	33° 42.114' N	118° 21.063' W	BA7BC-WO5-0915-1	Ocean water	5	9/24/15	1048
			BA7BC-WO50-0915-1	Ocean water	50	9/24/15	1057
			BA7BC-WO95-0915-1	Ocean water	91	9/24/15	1107
BA7C	33° 42.310' N	118° 20.920' W	BA7C-WO5-0315-1	Ocean water	5	3/31/15	1135
			BA7C-WO30-0315-1	Ocean water	30	3/31/15	1143
			BA7C-WO55-0315-1	Ocean water	55	3/31/15	1156
			BA7C-WO58-0315-1	Ocean water	58	3/31/15	1227
BA7DC	33° 42.570' N	118° 20.730' W	BA7DC-WO5-0915-1	Ocean water	5	9/22/15	1703
			BA7DC-WO20-0915-1	Ocean water	20	9/22/15	1655
			BA7DC-WO35-0915-1	Ocean water	35	9/22/15	1647
			BA7DC-WO38-0915-1	Replicate	39	9/22/15	1613
			BA7DC-WO38-0915-2	Ocean water	39	9/22/15	1626
			BA7DC-WO38-0915-3	Triplicate	39	9/22/15	1636
BA8B	33° 41.533' N	118° 20.238' W	BA8B-WO5-0915-1	Ocean water	5	9/24/15	0911
			BA8B-WO75-0915-1	Ocean water	75	9/24/15	0902
			BA8B-WO145-0915-1	Ocean water	142	9/24/15	0849
BA8BC	33° 41.635' N	118° 20.220' W	BA8BC-WO5-0915-1	Ocean water	5	9/24/15	0953
			BA8BC-WO50-0915-1	Ocean water	50	9/24/15	0920
			BA8BC-WO95-0915-1	Ocean water	92	9/24/15	0929
BA8C	33° 41.910' N	118° 20.140' W	BA8C-WO5-0915-1	Ocean water	5	9/24/15	10:01
			BA8C-WO30-0315-1	Ocean water	30	3/31/15	1246
			BA8C-WO55-0315-1	Ocean water	55	3/31/15	1258
			BA8C-WO58-03151	Replicate	58	3/31/15	1307
			BA8C-WO58-0315-2	Ocean water	58	3/31/15	1316
			BA8C-WO58-0315-3	Triplicate	58	3/31/15	1323
BA8DC	33° 42.220' N	118° 19.910' W	BA8DC-WO5-0915-1	Ocean water	5	9/24/15	1209
			BA8DC-WO20-0915-1	Ocean water	20	9/24/15	1204
			BA8DC-WO35-0915-1	Ocean water	35	9/24/15	1157
			BA8DC-WO38-0915-1	Ocean water	38	9/24/15	1149
BA9B	33° 40.892' N	118° 19.312' W	BA9B-WO5-0915-1	Ocean water	5	9/24/15	0831
			BA9B-WO75-0915-1	Ocean water	75	9/24/15	0824
			BA9B-WO145-0915-1	Ocean water	146	9/24/15	0810
BA9BC	33° 41.010' N	118° 19.247' W	BA9BC-WO5-0915-1	Ocean water	5	9/24/15	1229
			BA9BC-WO50-0915-1	Ocean water	50	9/24/15	1247
			BA9BC-WO95-0915-1	Ocean water	90	9/24/15	1237

Table 3-9 – Collection Data – High Resolution Grab Water Samples
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Grid ID	*Latitude*	*Longitude*	*Sample ID*	*Sample type*	*Depth* (m)	*Date*	*Time*
BA9C	33° 41.320' N	118° 19.100' W	BA9C-WO5-0915-1	Ocean water	5	9/24/15	1257
			BA9C-WO30-0915-1	Ocean water	30	9/24/15	1318
			BA9C-WO55-0915-1	Ocean water	56	9/24/15	1325
			BA9C-WO58-0915-1	Ocean water	58	9/24/15	1304
BA9DC	33° 41.770' N	118° 18.880' W	BA9DC-WO5-0315-1	Ocean water	5	3/31/15	0837
			BA9DC-WO20-0315-1	Ocean water	20	3/31/15	0858
			BA9DC-WO35-03151	Ocean water	35	3/31/15	0916
			BA9DC-WO38-0315-1	Replicate	38	3/31/15	0926
			BA9DC-WO38-0315-2	Ocean water	38	3/31/15	0934
			BA9DC-WO38-0315-3	Triplicate	38	3/31/15	0943
BA10B	33° 39.728' N	118° 17.902' W	BA10B-WO5-0915-1	Ocean water	5	9/25/15	0802
			BA10B-WO75-0915-1	Ocean water	75	9/25/15	0838
			BA10B-WO145-0915-1	Ocean Water	141	9/25/15	08:23
BA10C	33° 40.108' N	118° 17.813' W	BA10C-WO5-0915-1	Ocean water	5	9/25/15	0736
			BA10C-WO30-0915-1	Ocean water	30	9/25/15	0750
			BA10C-WO55-0915-1	Ocean water	56	9/25/15	0742
BA10D C	33° 41.147' N	118° 17.435' W	BA10DC-WO5-0915-1	Ocean water	5	9/15/15	1535
			BA10DC-WO20-0915-1	Ocean water	20	9/15/15	1603
			BA10DC-WO35-0915-1	Ocean water	35	9/15/15	1615
T11	33° 36.055' N	118° 05.199' W	T11-WO5-0915-1	Ocean water	5	9/25/15	1030
			T11-WO30-0915-1	Ocean water	30	9/25/15	1050
			T11-WO55-0915-1	Ocean water	55	9/25/15	1043
			T11-WO58-0915-1	Ocean water	58	9/25/15	1036
W1	33° 46.422' N	118° 27.269' W	W1-WO5-0915-1	Ocean water	5	9/16/15	0842
			W1-WO30-0915-1	Ocean water	30	9/16/15	0854
			W1-WO55-0915-1	Ocean water	57	9/16/15	0910
			W1-WO58-0915-1	Ocean water	60	9/16/15	0934
W2	33° 45.771' N	118° 27.668' W	W2-WO5-0915-1	Ocean water	5	9/23/15	1048
			W2-WO100-0915-1	Ocean water	100	9/23/15	0939
			W2-WO195-0915-1	Ocean water	192	9/23/15	1036
			W2-WO198-0915-1	Ocean water	202	9/23/15	0956
W3	33° 42.759' N	118° 23.078' W	W3-WO5-0915-1	Ocean water	5	9/17/15	1646
			W3-WO100-0915-1	Ocean water	100	9/17/15	1705
			W3-WO195-0915-1	Ocean water	187	9/22/15	0949
			W3-WO198-0915-1	Ocean water	200	9/17/15	1601

Table 3-9 – Collection Data – High Resolution Grab Water Samples
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Grid ID	*Latitude*	*Longitude*	*Sample ID*	*Sample type*	*Depth* (m)	*Date*	*Time*
W4	33° 41.559' N	118° 20.414' W	W4-WO5-0315-1	Ocean water	5	3/31/15	1014
			W4-WO100-0315-1	Ocean water	100	3/31/15	1029
			W4-WO195-0315-1	Ocean water	195	3/31/15	1048
			W4-WO198-0315-1	Ocean water	198	3/31/15	1113
W5	33° 40.085' N	118° 17.673' W	W5-WO5-0915-1	Ocean water	5	9/24/15	1350
			W5-WO30-0915-1	Ocean water	30	9/24/15	1418
			W5-WO55-0915-1	Ocean water	55	9/24/15	1411
			W5-WO58-0915-1	Ocean water	53	9/24/15	1356
			W5-WO58-0915-2	Replicate	53	9/24/15	1403
WE	NA	NA	WQ-ER1-0315-1	Equipment rinsate	NA	3/31/15	1335
			WQ-ER2-0915-1	Equipment rinsate	NA	9/22/15	1850
			WQ-ER3-0915-1	Equipment rinsate	NA	9/25/15	0905

Abbreviations

m = meters
NA = not applicable
WE = quality control equipment rinsate sample

Notes

1. Latitudes and longitudes are based on the Sanitation Districts' "benthic" sediment transects and grid nodes.
2. The sample type denotes replicate and triplicate samples collected from approximately the same water depth during sequential drops.
3. Actual sample depth below the ocean surface based on the nominal depths to the ocean floor at each planned mooring and the 3-depth or 4-depth sampling scheme employed. The field-measured depth is listed.

Table 3-10 — Total DDT Compounds in Water Along the 150-m Isobath
First MNR Report
Palos Verdes Shelf (OU5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Location	***Sample ID***	***Depth* (meters)**	***Concentration***	***Average***
Down-current of outfall diffusers - near-surface				
BA1B	BA1B-WO5-0915-1	5	0.028	-
BA2B	BA2B-WO5-0915-1	5	0.000	-
BA3B	BA3B-WO5-0915-1	5	0.0758	-
BA4B	BA4B-WO5-0915-1	5	0.0447	-
BA5B	BA5B-WO5-0915-1	5	0.0322	0.0361
Down-current of outfall diffusers - mid-column				
BA1B	BA1B-WO75-0915-1	75	0.773	-
BA2B	BA2B-WO75-0915-1	75	0.134	-
BA3B	BA3B-WO80-0915-1	80	0.200	-
BA4B	BA4B-WO75-0915-1	75	1.08	-
BA5B	BA5B-WO75-0915-1	75	0.571	0.551
Down-current of outfall diffusers - near-bottom				
BA1B	BA1B-WO145-0915-1	147	0.454	-
BA2B	BA2B-WO145-0915-1	145	0.273	-
BA3B	BA3B-WO145-0915-1	153	0.845	-
BA4B	BA4B-WO145-0915-1	141	1.27	-
BA5B	BA5B-WO145-0915-1	145	1.11	0.791
Vicinity of outfall diffusers - near-surface				
BA6B	BA6B-WO5-0915-1	5	0.0473	-
BA7B	BA7B-WO5-0915-1	5	0.0210	-
BA8B	BA8B-WO5-0915-1	5	0.0290	0.0324
Vicinity of outfall diffusers - mid-column				
BA6B	BA6B-WO75-0915-1	75	0.141	-
BA7B	BA7B-WO75-0915-1	75	0.106	-
BA8B	BA8B-WO75-0915-1	75	0.0837	0.110
Vicinity of outfall diffusers - near-bottom				
BA6B	BA6B-WO145-0915-1	130	0.425	-
BA7B	BA7B-WO145-0915-1	140	1.14	-
BA8B	BA8B-WO145-0915-1	142	0.939	0.833
Up-current of outfall diffusers - near surface				
BA9B	BA9B-WO5-0915-1	5	0.0300	-
BA10B	BA10B-WO5-0915-1	5	0.0153	0.0227
Up-current of outfall diffusers - mid-column				
BA9B	BA9B-WO75-0915-1	75	0.494	-
BA10B	BA10B-WO75-0915-1	75	0.0153	0.255
Up-current of outfall diffusers - near-bottom				
BA9B	BA9B-WO145-0915-1	146	0.563	-
BA10B	BA10B-WO145-0915-1	141	0.259	0.411

Notes
1. Concentrations and averages are in nanograms per liter (ng/L [parts per trillion (ppt)]).

Table 3-11 — Total DDT Compounds in Water Along the 60-m Isobath
First MNR Report
Palos Verdes Shelf (OU5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Location	*Sample ID*	*Depth* (meters)	*Concentration*	*Average*
Down-current of outfall diffusers - near-surface				
BA1C	BA1C-WO5-0915-1	5	0.0896	-
BA2C	BA2C-WO5-0915-1	5	0.00520	-
BA3C	BA3C-WO5-0915-1	5	0.0927	-
BA4C	BA4C-WO5-0915-1	5	0.0470	-
BA5C	BA5C-WO5-0915-1	5	0.0344	0.0538
Down-current of outfall diffusers - mid-column				
BA1C	BA1C-WO30-0915-1	30	0.352	-
BA2C	BA2C-WO30-0915-1	30	0.460	-
BA3C	BA3C-WO30-0915-1	30	0.684	-
BA4C	BA4C-WO30-0915-1	30	0.0684	-
BA5C	BA5C-WO30-0915-1	30	0.133	0.340
Down-current of outfall diffusers - near-bottom				
BA1C	BA1C-WO55-0915-1	57	0.714	-
BA1C	BA1C-WO60-0915-1	59	0.454	-
BA2C	BA2C-WO55-0915-1	55	0.277	-
BA3C	BA3C-WO55-0915-1	55	0.304	-
BA3C	BA3C-WO58-0915-1	58	0.416	-
BA4C	BA4C-WO55-0915-1	55	0.170	-
BA4C	BA4C-WO58-0915-1	58	3.26	-
BA5C	BA5C-WO55-0915-1	55	0.898	-
BA5C	BA5C-WO58-0915-1	59	1.59	0.897
Vicinity of outfall diffusers - near-surface				
BA6C	BA6C-WO5-0915-1	5	0.0714	-
BA7C	BA7C-WO5-0315-1	5	0.0140	-
BA8C	BA8C-WO5-0915-1	5	0.0413	0.0422
Vicinity of outfall diffusers - mid-column				
BA6C	BA6C-WO30-0915-1	30	0.635	-
BA7C	BA7C-WO30-0315-1	30	1.22	-
BA8C	BA8C-WO30-0315-1	30	0.00740	0.622
Vicinity of outfall diffusers - near-bottom				
BA6C	BA6C-WO55-0915-1	54	1.08	-
BA7C	BA7C-WO55-0315-1	55	0.00964	-
BA7C	BA7C-WO58-0315-1	58	0.000	-
BA8C	BA8C-WO55-0315-1	55	0.292	-
BA8C	BA8C-WO58-0315-2	58	0.265	0.329
Up-current of outfall diffusers - near surface				
BA9C	BA9C-WO5-0915-1	5	0.00674	-
BA10C	BA10C-WO5-0915-1	5	0.0224	0.0146
Up-current of outfall diffusers - mid-column				
BA9C	BA9C-WO30-0915-1	30	0.157	-
BA10C	BA10C-WO30-0915-1	30	0.000	0.0786
Up-current of outfall diffusers - near-bottom				
BA9C	BA9C-WO55-0915-1	56	0.197	-
BA9C	BA9C-WO58-0915-1	58	0.315	-
BA10C	BA10C-WO55-0915-1	56	0.457	0.323

Notes
1. Concentrations and averages are in nanograms per liter (ng/L [parts per trillion (ppt)])

Table 3-12 — Total DDT Compounds in Water Along the 40-m Isobath
First MNR Report
Palos Verdes Shelf (OU5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Location	*Sample ID*	*Depth* (meters)	*Concentration*	*Average*
Down-current of outfall diffusers - near-surface				
BA1DC	BA1DC-WO5-0915-1	5	0.0353	-
BA2DC	BA2DC-WO5-0915-1	5	0.101	-
BA3DC	BA3DC-WO5-0915-1	5	0.000	-
BA4DC	BA4DC-WO5-0915-1	5	0.118	-
BA5DC	BA5DC-WO5-0915-1	5	0.0218	0.0552
Down-current of outfall diffusers - mid-column				
BA1DC	BA1DC-WO20-0915-1	20	0.292	-
BA2DC	BA2DC-WO20-0915-1	20	0.336	-
BA3DC	BA3DC-WO20-0915-1	20	1.12	-
BA4DC	BA4DC-WO20-0915-1	20	0.302	-
BA5DC	BA5DC-WO20-0915-1	20	0.0135	0.412
Down-current of outfall diffusers - near-bottom				
BA1DC	BA1DC-WO35-0915-1	35	0.171	-
BA2DC	BA2DC-WO35-0915-1	39	0.305	-
BA3DC	BA3DC-WO35-0915-1	38	1.33	-
BA4DC	BA4DC-WO35-0915-1	36	1.50	-
BA5DC	BA5DC-WO35-0915-1	35	0.640	-
BA5DC	BA5DC-WO38-0915-1	38	1.81	0.959
Vicinity of outfall diffusers - near-surface				
BA6DC	BA6DC-WO5-0915-1	5	0.0712	-
BA7DC	BA7DC-WO5-0915-1	5	0.0374	-
BA8DC	BA8DC-WO5-0915-1	5	0.0370	0.0485
Vicinity of outfall diffusers - mid-column				
BA6DC	BA6DC-WO20-1115-1	20	0.284	-
BA7DC	BA7DC-WO20-0915-1	20	0.159	-
BA8DC	BA8DC-WO20-0915-1	20	0.141	0.195
Vicinity of outfall diffusers - near-bottom				
BA6DC	BA6DC-WO35-0915-1	35	1.72	-
BA7DC	BA7DC-WO35-0915-1	35	1.66	-
BA7DC	BA7DC-WO38-0915-2	39	1.09	-
BA8DC	BA8DC-WO35-0915-1	35	0.668	-
BA8DC	BA8DC-WO38-0915-1	38	0.728	1.17
Up-current of outfall diffusers - near surface				
BA9DC	BA9DC-WO5-0315-1	5	0.00410	-
BA10DC	BA10DC-WO5-0915-1	5	0.0280	0.0161
Up-current of outfall diffusers - mid-column				
BA9DC	BA9DC-WO20-0315-1	20	0.178	-
BA10DC	BA10DC-WO20-0915-1	20	0.000	0.0892
Up-current of outfall diffusers - near-bottom				
BA9DC	BA9DC-WO35-0315-1	35	0.202	-
BA9DC	BA9DC-WO38-0315-2	38	0.0466	-
BA10DC	BA10DC-WO35-0915-1	35	0.189	0.146

Notes
1. Concentrations and averages are in nanograms per liter (ng/L [parts per trillion (ppt)]).

Table 3-13 — Total PCBs in Water Along the 150-m Isobath
First MNR Report
Palos Verdes Shelf (OU5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Location	*Sample ID*	*Depth* (meters)	*Concentration*	*Average*
Down-current of outfall diffusers - near-surface				
BA1B	BA1B-WO5-0915-1	5	12.6	-
BA2B	BA2B-WO5-0915-1	5	17.0	-
BA3B	BA3B-WO5-0915-1	5	61.7	-
BA4B	BA4B-WO5-0915-1	5	25.7	-
BA5B	BA5B-WO5-0915-1	5	23.6	28.1
Down-current of outfall diffusers - mid-column				
BA1B	BA1B-WO75-0915-1	75	74.8	-
BA2B	BA2B-WO75-0915-1	75	24.2	-
BA3B	BA3B-WO80-0915-1	80	30.4	-
BA4B	BA4B-WO75-0915-1	75	73.7	-
BA5B	BA5B-WO75-0915-1	75	42.7	49.2
Down-current of outfall diffusers - near-bottom				
BA1B	BA1B-WO145-0915-1	147	43.0	-
BA2B	BA2B-WO145-0915-1	145	105	-
BA3B	BA3B-WO145-0915-1	153	68.8	-
BA4B	BA4B-WO145-0915-1	141	84.6	-
BA5B	BA5B-WO145-0915-1	145	90.7	78.4
Vicinity of outfall diffusers - near-surface				
BA6B	BA6B-WO5-0915-1	5	18.4	-
BA7B	BA7B-WO5-0915-1	5	1.62	-
BA8B	BA8B-WO5-0915-1	5	9.36	9.80
Vicinity of outfall diffusers - mid-column				
BA6B	BA6B-WO75-0915-1	75	22.1	-
BA7B	BA7B-WO75-0915-1	75	14.5	-
BA8B	BA8B-WO75-0915-1	75	32.1	22.9
Vicinity of outfall diffusers - near-bottom				
BA6B	BA6B-WO145-0915-1	130	50.1	-
BA7B	BA7B-WO145-0915-1	140	103	-
BA8B	BA8B-WO145-0915-1	142	75.7	76.3
Up-current of outfall diffusers - near surface				
BA9B	BA9B-WO5-0915-1	5	6.24	-
BA10B	BA10B-WO5-0915-1	5	0.350	3.30
Up-current of outfall diffusers - mid-column				
BA9B	BA9B-WO75-0915-1	75	54.1	-
BA10B	BA10B-WO75-0915-1	75	0.330	27.2
Up-current of outfall diffusers - near-bottom				
BA9B	BA9B-WO145-0915-1	146	65.9	-
BA10B	BA10B-WO145-0915-1	141	17.0	41.5

Notes
1. Concentrations and averages are in picograms per liter (pg/L [parts per quadrillion (ppq)]).

Table 3-14 — Total PCBs in Water Along the 60-m Isobath
First MNR Report
Palos Verdes Shelf (OU5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Location	*Sample ID*	*Depth* (meters)	*Concentration*	*Average*
Down-current of outfall diffusers - near-surface				
BA1C	BA1C-WO5-0915-1	5	22.8	-
BA2C	BA2C-WO5-0915-1	5	46.7	-
BA3C	BA3C-WO5-0915-1	5	12.6	-
BA4C	BA4C-WO5-0915-1	5	24.2	-
BA5C	BA5C-WO5-0915-1	5	19.1	25.1
Down-current of outfall diffusers - mid-column				
BA1C	BA1C-WO30-0915-1	30	45.6	-
BA2C	BA2C-WO30-0915-1	30	46.3	-
BA3C	BA3C-WO30-0915-1	30	52.6	-
BA4C	BA4C-WO30-0915-1	30	32.6	-
BA5C	BA5C-WO30-0915-1	30	24.2	40.3
Down-current of outfall diffusers - near-bottom				
BA1C	BA1C-WO55-0915-1	57	47.9	-
BA1C	BA1C-WO60-0915-1	59	46.3	-
BA2C	BA2C-WO55-0915-1	55	27.0	-
BA3C	BA3C-WO55-0915-1	55	28.0	-
BA3C	BA3C-WO58-0915-1	58	27.9	-
BA4C	BA4C-WO55-0915-1	55	49.3	-
BA4C	BA4C-WO58-0915-1	58	168	-
BA5C	BA5C-WO55-0915-1	55	76.1	-
BA5C	BA5C-WO58-0915-1	59	110	64.5
Vicinity of outfall diffusers - near-surface				
BA6C	BA6C-WO5-0915-1	5	43.4	-
BA7C	BA7C-WO5-0315-1	5	92.4	-
BA8C	BA8C-WO5-0915-1	5	3.77	46.5
Vicinity of outfall diffusers - mid-column				
BA6C	BA6C-WO30-0915-1	30	65.1	-
BA7C	BA7C-WO30-0315-1	30	185	-
BA8C	BA8C-WO30-0315-1	30	24.1	91.5
Vicinity of outfall diffusers - near-bottom				
BA6C	BA6C-WO55-0915-1	54	94.4	-
BA7C	BA7C-WO55-0315-1	55	26.8	-
BA7C	BA7C-WO58-0315-1	58	5.19	-
BA8C	BA8C-WO55-0315-1	55	63.3	-
BA8C	BA8C-WO58-0315-2	58	38.6	45.7
Up-current of outfall diffusers - near surface				
BA9C	BA9C-WO5-0915-1	5	12.0	-
BA10C	BA10C-WO5-0915-1	5	6.44	9.20
Up-current of outfall diffusers - mid-column				
BA9C	BA9C-WO30-0915-1	30	40.5	-
BA10C	BA10C-WO30-0915-1	30	2.12	21.3
Up-current of outfall diffusers - near-bottom				
BA9C	BA9C-WO55-0915-1	56	24.5	-
BA9C	BA9C-WO58-0915-1	58	31.0	-
BA10C	BA10C-WO55-0915-1	56	30.7	28.7

Notes
1. Concentrations and averages are in picograms per liter (pg/L [parts per quadrillion (ppq)]).

Table 3-15 — Total PCBs in Water Along the 40-m Isobath
First MNR Report
Palos Verdes Shelf (OU5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Location	*Sample ID*	*Depth* (meters)	*Concentration*	*Average*
Down-current of outfall diffusers - near-surface				
BA1DC	BA1DC-WO5-0915-1	5	27.8	-
BA2DC	BA2DC-WO5-0915-1	5	32.2	-
BA3DC	BA3DC-WO5-0915-1	5	8.98	-
BA4DC	BA4DC-WO5-0915-1	5	31.9	-
BA5DC	BA5DC-WO5-0915-1	5	19.6	24.1
Down-current of outfall diffusers - mid-column				
BA1DC	BA1DC-WO20-0915-1	20	39.6	-
BA2DC	BA2DC-WO20-0915-1	20	33.9	-
BA3DC	BA3DC-WO20-0915-1	20	90.1	-
BA4DC	BA4DC-WO20-0915-1	20	38.4	-
BA5DC	BA5DC-WO20-0915-1	20	13.7	43.1
Down-current of outfall diffusers - near-bottom				
BA1DC	BA1DC-WO35-0915-1	35	26.0	-
BA2DC	BA2DC-WO35-0915-1	39	25.5	-
BA3DC	BA3DC-WO35-0915-1	38	95.8	-
BA4DC	BA4DC-WO35-0915-1	36	103	-
BA5DC	BA5DC-WO35-0915-1	35	53.0	-
BA5DC	BA5DC-WO38-0915-1	38	120	70.6
Vicinity of outfall diffusers - near-surface				
BA6DC	BA6DC-WO5-0915-1	5	19.4	-
BA7DC	BA7DC-WO5-0915-1	5	10.6	-
BA8DC	BA8DC-WO5-0915-1	5	15.5	15.2
Vicinity of outfall diffusers - mid-column				
BA6DC	BA6DC-WO20-1115-1	20	14.7	-
BA7DC	BA7DC-WO20-0915-1	20	57.7	-
BA8DC	BA8DC-WO20-0915-1	20	106	59.3
Vicinity of outfall diffusers - near-bottom				
BA6DC	BA6DC-WO35-0915-1	35	139	-
BA7DC	BA7DC-WO35-0915-1	35	104	-
BA7DC	BA7DC-WO38-0915-2	39	88.4	-
BA8DC	BA8DC-WO35-0915-1	35	79.8	-
BA8DC	BA8DC-WO38-0915-1	38	74.2	97.1
Up-current of outfall diffusers - near surface				
BA9DC	BA9DC-WO5-0315-1	5	42.1	-
BA10DC	BA10DC-WO5-0915-1	5	18.9	30.5
Up-current of outfall diffusers - mid-column				
BA9DC	BA9DC-WO20-0315-1	20	70.5	-
BA10DC	BA10DC-WO20-0915-1	20	11.7	41.1
Up-current of outfall diffusers - near-bottom				
BA9DC	BA9DC-WO35-0315-1	35	49.1	-
BA9DC	BA9DC-WO38-0315-2	38	7.40	-
BA10DC	BA10DC-WO35-0915-1	35	34.5	30.3

Notes
1. Concentrations and averages are in picograms per liter (pg/L [parts per quadrillion (ppq)]).

Table 3-16 — Summary of Fish Collections
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Collection area	*Longitude*	*Latitude*	*Catch date*	*BSB collected*	*WC collected*	*Sample names*	*Caught by*	*Catch method*
Huntington Flats	118° 03.403' W	33° 39.301' N	7/20/2015	1	0	HFBSB-2015-01	Seaventures	Trap
			7/15-18/2016	29	0	HFBSB-2016-02 through HFBSB-2016-30	Seaventures	Trap, H&L
Subtotal Huntington Flats				*30*	*0*			
Redondo Flats	118° 25.066' W	33° 51.379' N	7/15/2015	2	0	RFBSB-2015-01 through RFBSB-2015-02	Seaventures	Trap
			7/17/2015	1	0	RFBSB-2015-03	Seaventures	Trap
			7/18/2015	5	0	RFBSB-2015-04 through RFBSB-2015-08	Seaventures	Trap, H&L
			7/19/2015	0	5	RFWC-2015-01 through RFWC-2015-05	Seaventures	Trawl
			7/19-24/2016	18	3	RFBSB-2016-09 to -26, RFWC-2016-06 to -08	Seaventures	H&L, Trawl
Subtotal Redondo Flats				*26*	*8*			
Ventura Flats	119° 19.639' W	34° 14.195' N	7/16/2015	0	30	VFWC-2015-01 through VFWC-2015-30	Seaventures	Trawl
Zone 1	118° 19.966' W	33° 42.157' N	6/10/2014	3	0	Z1BSB-2014-01 through Z1BSB-2014-03	Sanitation Districts	Trap
			6/13/2014	1	0	Z1BSB-2014-04	Sanitation Districts	Trap
			9/29/2014	1	0	Z1BSB-2014-05	Sanitation Districts	Trap
			10/1/2014	5	0	Z1BSB-2014-06 through Z1BSB-2014-10	Sanitation Districts	Trap
			10/2/2014	1	0	Z1BSB-2014-11	Sanitation Districts	Trap
			10/20/2014	0	30	Z1WC-2014-01 through Z1WC-2014-30	Sanitation Districts	Trawl
			12/5/2014	8	0	Z1BSB-2014-12 through Z1BSB-2014-19	Sanitation Districts	Trap
			12/9/2014	4	0	Z1BSB-2014-20 through Z1BSB-2014-23	Sanitation Districts	Trap
			12/22/2014	7	0	Z1BSB-2014-24 through Z1BSB-2014-30	Sanitation Districts	Trap
Subtotal Zone 1				*30*	*30*			
Zone 2	118° 24.061' W	33° 44.051' N	7/15/2014	1	0	Z2BSB-2014-01	Sanitation Districts	Trap
			8/19/2014	1	0	Z2BSB-2014-02	Sanitation Districts	Trap
			10/1/2014	1	0	Z2BSB-2014-03	Sanitation Districts	Trap
			10/20/2014	0	30	Z2WC-2014-01 through Z2WC-2014-30	Sanitation Districts	Trawl
			5/13/2015	2	0	Z2BSB-2014-04 through Z2BSB-2014-05	Sanitation Districts	Trap
			5/14/2015	1	0	Z2BSB-2014-06	Sanitation Districts	Trap
			5/21/2015	2	0	Z2BSB-2014-07 through Z2BSB-2014-08	Sanitation Districts	Trap
			6/2/2015	4	0	Z2BSB-2014-09 through Z2BSB-2014-12	Sanitation Districts	Trap
Subtotal Zone 2				*12*	*30*			
Zone 3	118° 25.808' W	33° 47.990' N	10/20/2014	0	14	Z3WC-2014-01 through Z3WC-2014-14	Sanitation Districts	Trawl
			10/21/2014	0	16	Z3WC-2014-15 through Z3WC-2014-30	Sanitation Districts	Trawl
			7/15/2015	1	0	Z3BSB-2014-01	Sanitation Districts	Trap
			7/17/2015	3	0	Z3BSB-2014-02 through Z3BSB-2014-04	Sanitation Districts	Trap
			5/13/2016	0	0	No BSB or WC caught	NA	Trap
			5/27/2016	0	0	No BSB or WC caught	NA	Trap
			6/28/2016	3	0	Z3BSB-05 through Z3BSB-07	Sanitation Districts	Spear
			7/6/2016	3	0	Z3BSB-08 through Z3BSB-10	Sanitation Districts	Spear
			7/29/2016	3	0	Z3BSB-11 through Z3BSB-13	Sanitation Districts	Spear
			8/4/2016	1	0	Z3BSB-14	Sanitation Districts	Trap
			8/22, 8/26, 8/31	0	0	No BSB or WC caught	NA	Trap, spear
Subtotal Zone 3				*14*	*30*			
Breakwater Zone	118° 12.639' W	33° 42.261' N	7/2/2014	1	0	BWBSB-2014-01	Sanitation Districts	Trap
			7/3/2014	2	0	BWBSB-2014-02, BWBSB-2014-03	Sanitation Districts	Trap
			7/14/2014	7	0	BWBSB-2014-04 through BWBSB-2014-10	Sanitation Districts	H&L
			10/21/2014	0	5	BWWC-2014-01 through BWWC-2014-05	Sanitation Districts	Trawl
			10/22/2014	0	25	BWWC-2014-06 through BWWC-2014-30	Sanitation Districts	Trawl
			10/22/2014	4	0	BWBSB-2014-11 through BWBSB-2014-14	Sanitation Districts	Trap
			4/15/2015	3	0	BWBSB-2014-15 through BWBSB-2014-17	Sanitation Districts	Trap
			6/9/2015	2	0	BWBSB-2014-18 through BWBSB-2014-19	Sanitation Districts	Trap
			6/10/2015	1	0	BWBSB-2014-20	Sanitation Districts	Trap
			6/16/2015	2	0	BWBSB-2014-21 through BWBSB-2014-22	Sanitation Districts	Trap
			6/30/2015	2	0	BWBSB-2014-23 through BWBSB-2014-24	Sanitation Districts	Trap
			7/14/2015	1	0	BWBSB-2014-25	Sanitation Districts	Trap
			4/19/2016	6	0	BWBSB-2014-26 through BWBSB-2014-31	Sanitation Districts	H&L, trap
Subtotal Breakwater Zone				*31*	*30*			
TOTALS FOR OUTFALL AREA				**87**	**120**			
GRAND TOTAL			**301**	**143**	**158**			
Planned			*340*	*160*	*180*			

Abbreviations:
BSB - Barred sand bass (Paralabrax nebulifer)
H&L - Hook and line
NA - Not applicable
NAD - North American Datum
WC - White croaker (Genyonemus lineatus)

Notes:
1. Latitude and longitude coordinates are for the approximate center point of the relevant fish collection area, in degrees-decimal minutes; geographic coordinate system is NAD 83.
2. Fish collection areas are shown on Figure 2-5.

Table 3-17 — Total DDTs in Fish
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Fish identifier	Barred sand bass						White croaker					
	Breakwater Zone	*Huntington Flats*	*Redondo Flats*	*Zone 1*	*Zone 2*	*Zone 3*	*Breakwater Zone*	*Redondo Flats*	*Ventura Flats*	*Zone 1*	*Zone 2*	*Zone 3*
1	**22.2**	**172**	**31.1**	**155**	**39.2**	**19.5**	**287**	**382**	**11**	**603**	**598**	**580**
2	**155**	**21.3**	**35.8**	**146**	**93.3**	**35**	**105**	**508**	**10.8**	**1,280**	**1,040**	**528**
3	**57.4**	**124**	**112**	**105**	**64.4**	**245**	**293**	**163**	**5.71**	**1,180**	**856**	**245**
4	**99.2**	**205**	**101**	**137**	**225**	**219**	**57**	**118**	**17.1**	**348**	**410**	**685**
5	**70.5**	**134**	**78.3**	**331**	**371**	**250**	**81.8**	**195**	**7.72**	**451**	**611**	**268**
6	**48.1**	**59**	**105**	**100**	**198**	**32.7**	**166**	**247**	**9.06**	**580**	**341**	**496**
7	**78.3**	**141**	**114**	**501**	**44.9**	**58.7**	**280**	**79.8**	**8.11**	**401**	**711**	**433**
8	**26.2**	**58.4**	**122**	**206**	**60.8**	**61**	**294**	**82.9**	**6.51**	**236**	**865**	**469**
9	**201**	**47.7**	**8.77**	**72.6**	**296**	**18.6**	**308**		**12.5**	**416**	**129**	**248**
10	**31.5**	**27.7**	**22.4**	**133**	**83.8**	**13.4**	**421**		**16.1**	**1,290**	**347**	**183**
11	**91.7**	**20.4**	**153**	**191**	**114**	**177**	**622**		**8.13**	**265**	**136**	**424**
12	**247**	**30.6**	**15.5**	**565**	**40.4**	**156**	**264**		**6.46**	**2,080**	**182**	**515**
13	**121**	**137**	**34.2**	**518**		**32.8**	**434**		**4.83**	**693**	**110**	**1,530**
14	**56.5**	**84.9**	**50.4**	**551**		**37.5**	**585**		**6.94**	**295**	**758**	**551**
15	**41.3**	**130**	**73.1**	**529**			**233**		**7.32**	**680**	**2,000**	**365**
16	**49.5**	**62.7**	**25.1**	**302**			**333**		**17.7**	**187**	**991**	**207**
17	**31**	**64.7**	**22.7**	**536**			**341**		**7.5**	**389**	**2,030**	**84.4**
18	**93**	**20.2**	**9.99**	**116**			**331**		**7.77**	**229**	**1,680**	**1,020**
19	**45.5**	**543**	**66.9**	**214**			**374**		**4.49**	**2,360**	**1,060**	**81.7**
20	**24.6**	**95.2**	**36.1**	**74.5**			**316**		**5.66**	**347**	**632**	**281**
21	**38.7**	**29.3**	**39.6**	**17.6**			**253**		**20.4**	**836**	**1,600**	**553**
22	**160**	**119**	**25.6**	**91.1**			**517**		**21.3**	**1,700**	**355**	**259**
23	**85.1**	**32.6**	**46.1**	**662**			**91.7**		**16.2**	**311**	**552**	**166**
24	**27.6**	**147**	**26.1**	**37.6**			**383**		**18.8**	**1,400**	**472**	**335**
25	**136**	**143**	**47.1**	**297**			**187**		**16.1**	**678**	**852**	**381**
26	**23.9**	**29.1**	**15.1**	**107**			**120**		**17.4**	**390**	**508**	**353**
27	**47.8**	**52.6**		**508**			**199**		**16.2**	**834**	**551**	**561**
28	**51.5**	**10.7**		**701**			**341**		**17.6**	**2,110**	**1,180**	**281**
29	**37.4**	**31.5**		**325**			**164**		**17.4**	**157**	**1,410**	**160**
30	**90.9**	**28.9**		**339**			**129**		**9.97**	**225**	**215**	**256**
31	**46.4**											
Summary statistics												
Minimum	22.2	10.7	8.77	17.6	39.2	13.4	57	79.8	4.49	157	110	81.7
Median	51.5	60.9	37.9	210	88.6	48.1	290	179	10.4	516	622	359
Mean	75.3	93.4	54.5	286	136	96.9	284	222	11.8	765	773	417
95% UCL	94.2	126	72.1	376	227	172	328	324	13.4	995	939	515
Maximum	247	543	153	701	371	250	622	508	21.3	2,360	2,030	1,530
StDev	55.3	101	40.3	206	111	91.0	143	152	5.3	627	536	289
N	31	30	26	30	12	14	30	8	30	30	30	30
N >= IROD goal	NA	NA	NA	NA	NA	NA	5	1	0	18	22	13

Notes
1. All Total DDTs are in micrograms per kilogram (ug/kg).
2. Total DDTs is the sum of six target DDT isomers (o,p'-DDD, o,p'-DDE, o,p'-DDT, p,p'-DDD, p,p'-DDE, p,p'-DDT).
3. Shaded cells show Total DDTs greater than the IROD Remedial Action Objective (RAO) for white croaker ingestion of 400 ug/kg
4. In calculating summations of Total DDTs, nondetects were assumed to have a value of the EDL

Abbreviations
DDD - Dichlorodiphenyldichloroethane
DDE - Dichlorodiphenyldichloroethene
DDT - Dichlorodiphenyltrichloroethane
EDL - Estimated detection limit (sample specific)
IROD - Interim Record of Decision
N - Number of fish
NA - Not available
RAO - Remedial Action Objective
StDev - Standard deviation
UCL - Upper confidence limit (of the mean)
ug/kg - Micrograms per kilogram
>= - Greater than or equal to

Table 3-18 — Total DDT Compounds in Fish
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Fish identifier	Barred sand bass						White croaker					
	Breakwater Zone	Huntington Flats	Redondo Flats	Zone 1	Zone 2	Zone 3	Breakwater Zone	Redondo Flats	Ventura Flats	Zone 1	Zone 2	Zone 3
1	23.6	183	32.1	172	42.9	20.3	315	417	11.6	834	796	673
2	163	22.5	37.7	158	107	36	115	545	11.3	1,690	1,360	584
3	61.1	133	120	114	68.9	256	318	180	6.07	1,640	1,330	287
4	105	220	107	151	236	230	64.3	128	18.2	415	562	819
5	73.6	142	81.6	360	408	261	88.5	210	8.17	536	886	307
6	51.3	71	110	106	228	33.8	191	268	9.75	690	489	564
7	79.7	149	120	557	49.6	62.6	306	92.2	8.59	536	993	551
8	28.1	62.4	128	218	68.4	64.5	327	92.9	6.82	282	1,360	534
9	214	51.3	9.45	80.4	331	19.5	335		12	495	315	278
10	33.6	29.3	23.5	151	94.1	14.4	468		15.9	1,760	448	204
11	95.9	21.7	163	208	135	187	696		7.88	319	167	473
12	256	33.1	16.7	672	42.5	165	298		6.18	2,860	225	564
13	131	148	36	591		34.1	480		4.64	789	131	1,970
14	61.6	88.8	53.5	654		38.8	646		6.76	368	887	611
15	42.5	143	79.9	607			264		7.17	854	2,620	450
16	51.2	67.2	26.6	360			371		18.5	259	1,400	234
17	32.5	68.6	24.4	639			385		7.34	490	2,590	94.3
18	97.1	21.5	10.8	134			380		8.07	291	1,950	1,260
19	47.2	589	70.9	234			415		4.39	3,230	1,470	91.6
20	25.5	106	39.3	79.9			358		5.58	433	736	305
21	41	31.6	42.8	22.2			272		21.3	1,040	1,940	606
22	167	130	27.9	94.8			569		22.2	2,430	411	297
23	89.8	34.8	49.4	796			100		16.6	377	747	208
24	29.1	163	28.1	39.7			423		19.6	1,810	554	394
25	140	155	50.6	314			207		16.5	928	1,190	422
26	25	30.7	16.3	118			131		18	447	681	411
27	50.5	55.8		548			220		16.7	1,220	701	670
28	53.2	11.4		810			383		18.4	3,010	1,590	314
29	38.7	35		361			179		18.3	194	1,940	177
30	94.2	31.9		382			143		10.6	272	249	284
31	49											
Summary statistics												
Minimum	23.6	11.4	9.45	22.2	42.5	14.4	64.3	92.2	4.39	194	131	91.6
Median	53.2	67.9	41.1	226	100.6	50.7	316.5	195	11.0	613	841	416.5
Mean	79.1	101.0	57.9	324	151	101.6	315	242	12.1	1,017	1,024	488
95% UCL	98.8	136	76.5	430	214	180	364	351	13.8	1,440	1,240	609
Maximum	256	589	163	810	408	261	696	545	22.2	3,230	2,620	1,970
StDev	57.9	109	42.6	243	122	95.4	159	163	5.6	886	688	368
N	31	30	26	30	12	14	30	8	30	30	30	30

Notes
1. All Total DDT Compounds are in micrograms per kilogram (ug/kg).
2. Total DDT Compounds is the sum of eight target DDT isomers: o,p'-DDD, o,p'-DDE, o,p'-DDT, p,p'-DDD, p,p'-DDE, p,p'-DDT, p,p'-DDMU and p,p'-DDNU.
3. In calculating summations of Total DDT Compounds, nondetects were assumed to have a value of the EDL

Abbreviations
DDD - Dichlorodiphenyldichloroethane
DDE - Dichlorodiphenyldichloroethene
DDMU - 1,1-Bis(4-chlorophenyl)-2-chloroethene
DDNU - 1,1-Bis(4-chlorophenyl)ethene
DDT - Dichlorodiphenyltrichloroethane
EDL - Estimated detection limit (sample specific)
N - Number of fish
StDev - Standard deviation
UCL - Upper confidence limit (of the mean)
ug/kg - Micrograms per kilogram

Table 3-19 — Total PCBs in Fish
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Fish identifier	Barred sand bass						White croaker					
	Breakwater Zone	*Huntington Flats*	*Redondo Flats*	*Zone 1*	*Zone 2*	*Zone 3*	*Breakwater Zone*	*Redondo Flats*	*Ventura Flats*	*Zone 1*	*Zone 2*	*Zone 3*
1	21.3	20.3	16	19.5	9.13	4.22	52.1	62.5	3.37	79.9	89.5	55.6
2	22.6	20	12.9	37.3	21.1	4.19	21.3	146	2.4	89.3	115	61
3	8.01	133	128	16.7	38.3	34.6	33.8	42	1.34	103	109	30
4	22.2	65.8	41.6	17.2	32.5	22.9	10.6	30.9	3.85	42.9	63.6	102
5	24	71.1	32.8	27.3	66	38.5	16.7	68.6	1.96	45.8	102	35.8
6	16.3	32.7	58.3	22.8	47.4	7.74	46.2	112	2.43	62.2	71.9	90.7
7	36.2	40.4	28.3	53.3	4.39	7.62	58.5	26.5	2.32	65.9	118	57.1
8	11.4	27.7	30.1	22.8	7.17	28.4	55.3	73.8	1.95	45.4	111	41
9	29.8	63.5	11.3	19.2	21.7	5.56	64.7		3.37	62.1	76	29.7
10	11.6	28.6	16.2	16.7	13.8	9.72	59.4		3.09	115	71.7	62.2
11	19.4	17.5	58.2	22.9	6.87	21.2	81		1.96	40.5	43.2	39.4
12	77.3	15.2	6.83	37.8	3.77	25.4	55.1		1.82	186	29.5	66.6
13	13.9	171	10.1	39		4.89	76.8		1.75	118	24.7	164
14	7.4	46.4	20.2	50.5		11.1	75.9		1.78	45.5	145	70.6
15	8.95	44.5	26.4	60.2			68		1.82	154	225	30.7
16	5.84	29.7	11.2	32.3			47.3		2.06	46.5	176	76.8
17	6.1	32.9	15.5	31.9			70.9		2.53	41.8	196	14.9
18	21	8.85	4.96	16.1			72.5		2.12	63.5	256	62.8
19	11.9	164	42.4	65.8			64.8		1.9	138	225	9.98
20	14.1	39.9	24.2	9.5			65.3		2.22	40.9	173	21.2
21	5.81	12.9	25.2	7.05			46.3		4.95	72.3	161	54.9
22	23.8	42.7	20.9	14.8			87.4		4.79	134	83.4	38.7
23	9.65	20.3	18.1	87.5			35.2		3.94	42	69.1	35.9
24	7.76	33.3	18	6.46			69.2		5.14	122	50.9	31.4
25	17.1	36.6	30.1	50.3			33.5		2.91	78.8	168	64.7
26	4.24	9.25	8.43	17.9			26.6		3.92	49.5	59.4	26
27	13.3	49.9		76.1			34.9		3.83	80.5	54.3	37.2
28	18.8	12.3		106			59		2.91	199	167	43.9
29	27.5	14.1		16.6			33.5		2.84	59.8	152	27.7
30	28.8	7.68		43.1			38.3		3.33	40.9	50.3	38.1
31	4.83											
Summary statistics												
Minimum	4.24	7.68	4.96	6.46	3.77	4.19	10.6	26.5	1.34	40.5	24.7	9.98
Median	14.1	32.8	20.6	25.1	17.5	10.4	55.2	65.6	2.48	64.7	106	40.2
Mean	17.8	43.7	27.5	34.8	22.7	16.1	52.0	70.3	2.82	82.2	115	50.7
95% UCL	22.2	57.8	36.2	44.0	32.9	25.4	58.2	97.8	3.14	97.6	134	60.1
Maximum	77.3	171	128	106	66.0	38.5	87.4	146	5.14	199	256	164
StDev	13.9	42.0	24.9	24.6	19.7	12.0	20.1	41.1	1.03	44.8	63.0	30.4
N	31	30	26	30	12	14	30	8	30	30	30	30
N >= IROD RAO	NA	NA	NA	NA	NA	NA	6	3	0	14	21	5

Notes
1. Total PCBs is the sum of 46 PCB congeners: 8, 18, 28, 31, 37, 44, 49, 52, 66, 70, 74, 77*, 81*, 87, 99, 101, 105*, 110, 114*, 118*, 119, 123*, 126*, 128, 138, 149, 151, 153, 156*, 157*, 158, 167*, 168, 169*, 170, 177, 180, 183, 187, 189*, 194, 195, 201, 203, 206, and 209. The list includes 12 dioxin-like congeners designated with an asterisk (e.g., PCB 126*).
2. All Total PCBs are in micrograms per kilogram (ug/kg)
3. Shaded cells show Total PCBs greater than the IROD Remedial Action Objective (RAO) for white croaker ingestion of 70 ug/kg.
4. In calculating summations of Total PCBs, nondetects were assumed to have a value of the EDL.

Abbreviations
EDL - Estimated detection limit (sample specific)
IROD - Interim Record of Decision
N - Number of fish
NA - Not available
PCB - Polychlorinated biphenyl
RAO - Remedial Action Objective
StDev - Standard deviation
UCL - Upper confidence limit (of the mean)
ug/kg - Micrograms per kilogram
>= - Greater than or equal to

Table 4-1 – History of Mass Estimates of COCs at PV Shelf
First MNR Report
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*[a]**
119.6	NA	43.8	Gravity cores collected by Sanitation Districts 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	ITSI Gilbane, 2013
13.8	1.0	29.8	2009 gravity cores from 59 stations	Kriging using MVS with adaptive gridding	ITSI Gilbane, 2013
30	2.9 (5.9)[b]	29.8	2013 gravity cores from 65 stations	Kriging using MVS with 20,000 horizontal to vertical anisotrop	Appendix C (this report)

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

Superscript Notes
[a] References are provided in Section 6.0 of this report.
[b] Mass of PCBs provided as 2009 list of congeners result with 2013 expanded list of congener result in parentheses.

Table 4-2 — Comparison of Sediment Results - 2009 versus 2013
First MNR Report
Palos Verdes Shelf (OU5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Location	Field sample ID	Lab sample ID	Orginal ID	Year of collection	SBD-SED	o,p'-DDD	o,p'-DDE	o,p'-DDT	p,p'-DDD	p,p'-DDE	p,p'-DDT	Total DDTs	DDMU	DDNU	Total DDT Compounds	Total PCBs
BA5B	PVSED-001	17-03-0175-1	BA5B01200905	2009	4-6	200	1,400	27.0 J	510	10,000	140	12,000	3,000	210	15,000	1,900
	PVSED-003	17-03-0175-3	BA5B01201305	2013	4-6	260	1,900	49.0 J	670	12,000	440	15,000	6,200	240	22,000	3,900
	PVSED-002	17-03-0175-2	BA5B01200907	2009	6-8	260	2,000	60.0 J	700	15,000	600	19,000	4,000	280	23,000	3,000
	PVSED-004	17-03-0175-4	BA5B01201307	2013	6-8	460	3,300	65.0 J	1,100	18,000	370	23,000	14,000	390	38,000	5,000
BA6BC	PVSED-005	17-03-0175-5	BA6BC01200905	2009	4-6	180	1,200	50	590	7,700	290	10,000	3,800	170	14,000	1,500
	PVSED-007	17-03-0175-7	BA6BC01201305	2013	4-6	210	1,200	43	680	5,400	740	8,300	7,000	210	15,000	2,200
	PVSED-006	17-03-0175-6	BA6BC01200907	2009	6-8	240	1,400	32.0 J	1,300	8,100	340	11,000	6,200	240	18,000	2,800
	PVSED-008	17-03-0175-8	BA6BC01201307	2013	6-8	470	2,400	70.0 J	1,400	7,600	930	13,000	16,000	340	29,000	5,100
BA9C	PVSED-009	17-03-0175-9	BA9C01200903	2009	2-4	86	520	17.0 J	260	2,700	370	4,000	1,100	49	5,100	570
	PVSED-010	17-03-0175-10	BA9C01201303	2013	2-4	19.0 J	110	3.40 J	57	650	19.0 J	860	250	18.0 J	1,100	140
OA10	PVSED-011	17-03-0175-11	OA1001200901	2009	0-2	97	690	16.0 J	380	4,400	1,000	6,600	1,300	71	8,000	740
	PVSED-014	17-03-0175-14	OA1001201301	2013	0-2	81	560	13.0 J	280	3,400	230	4,600	1,400	78	6,000	650
	PVSED-012	17-03-0175-12	OA1001200905	2009	4-6	80	640	23.0 J	300	3,900	780	5,700	1,400	64	7,200	990
	PVSED-015	17-03-0175-15	OA1001201305	2013	4-6	210	1,300	120	660	6,900	1,300	10,000	3,500	150	14,000	1,400
	PVSED-013	17-03-0175-13	OA1001200907	2009	6-8	200	1,500	31.0 J	720	8,900	950	12,000	4,500	150	17,000	2,000
	PVSED-016	17-03-0175-16	OA1001201307	2013	6-8	460	3,300	130	1,500	15,000	1,400	22,000	12,000	420	34,000	7,300
OA11	PVSED-017	17-03-0175-17	OA1101200901	2009	0-2	150	1,500	32.0 J	500	9,400	1,400	13,000	2,400	110	15,000	1,700
	PVSED-019	17-03-0175-19	OA1101201301	2013	0-2	59	750	12.0 J	230	4,200	670	5,900	1,600	49	7,600	860
	PVSED-018	17-03-0175-18	OA1101200905	2009	4-6	80	720	17.0 J	400	4,500	350	6,100	1,100	44	7,200	700
	PVSED-020	17-03-0175-20	OA1101201305	2013	4-6	84	990	15.0 J	300	5,700	460	7,500	2,200	61	9,800	1,200

Notes
1. SBD-SED is the depth interval in the sediment bed, in centimeters. For example, when SBD-SED = 2-4, the interval begins at a bed depth of 2 centimeters and ends at 4 centimeters.
2. All concentrations of DDTs and PCBs are in micrograms per kilogram (ug/kg = parts per billion).

Table 4-3 — Comparison of Outputs of Geostatistical Models
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

	Total DDTs			Total DDT Compounds			Total PCBs - expanded list		
	Primary model	Secondary model	RPD (%)	Primary model	Secondary model	RPD (%)	Primary model	Secondary model	RPD (%)
Average concentrations									
Shelf-wide sediment									
Total bed	3,300	2,500	-28	4,700	3,400	-28	400	270	-39
0-8 cm interval	1,800	1,500	-18	2,500	2,100	-16	240	190	-23
Total mass									
Shelf-wide sediment									
Total bed	42,000	38,000	-10	61,000	52,000	-15	5,900	4,100	-36
0-8 cm interval	3,600	3,900	8	5,000	5,300	6	570	470	-19

Abbreviations
cm - Centimeter
OC - Organic carbon
RPD - Relative percent difference

Notes
1. Values of average concentrations are in micrograms per kilogram OC normalized.
2. Values of total mass are in kilograms.
3. The outputs from the secondary model are averages of concentrations obtained from several model runs that used different values for horizontal-to-vertical anisotropy (see Appendix AA).

Table 4-4 - Comparison of DDTs in Water
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Nominal sample depth (m)		*Near-surface (-5 m)*			*Mid-column (~1/2 total depth)*				*Near-bottom (+5 m)*					*Bottom (+2 m)*		*Bottom (+1 m)*
Sample type		*PED*	*SPME*	*Grab*	*Pump*	*PED*	*SPME*	*Grab*	*Pump*	*PED*		*SPME*	*Grab*	*Pump*	*Grab*	*Pump*
Location	*Total depth (m)*	*2013*	*2013*	*2015*	*1997*	*2013*	*2013*	*2015*	*1997*	*2010*	*2013*	*2013*	*2015*	*1997*	*2015*	*1997*
BA1C	60	117		87.0		1,780		219		2,170	4,290		434		256	
BA3C	60	196		76.0 (223)		2,250		419		NA	4,330		178		248	3,650
BA4C	60	162	157	44.0		1,940	826	63.0		4,960	10,500	2,139	170		1,590	
BA5C	60	135		33.3		2,610		128		4,700	7,010		560		1,000 (1,200)	4,350
BA5DC	40	196		21.8		1,490		13.5		3,490	4,300		430		1,100 (972)	
BA6B	150			36.1				86.9					196			3,050
BA6C	60			44.8	550			381	4,500				690	5,350		6,400
BA6DC	40			46.9				160					1,030			
BA6D	30															2,850
BA7C	60	135	154	14		1,740	973	949		NA	6,620	2,669	7.40		ND	4,500
BA7DC	40	136		37.1		1,000		151		3,640	2,990		1,040		700 (803)*	
BA8C	60	NA	142	25.9		1,420	841	7.40		3,110	1,520	2,053	292		234 (383)*	
BA8DC	40	77.5		23.3		561		104		2,860	3,370		490		510	
BA9C	60	NA	114	0.87		517	426	103		1,440	1,240	1,013	130		200	3,150
BA9DC	40	105		4.10		564		154		2,130	1,330		168		45.6 (141)*	
W1	60	84.3		NA		854		142			1,530		99.2		240	
0C	60															2,050
W2	200	73.4		41.0		335		88.6			1,190		261		231	
W3	200	76.4	127	ND		409	550	167			1,890	2,151	500		1,270	
W4	200	41.2		103		354		141			1,250		540		107	
W5	60	NA		15.4		NA		48.3			NA		12.8 (17.0)		23.6	
T11	60	ND	72	ND		24.6	93	30.8		81.8	38.6	ND	ND		ND	

Abbreviations
AWQC - Ambient Water Quality Criteria
DDD - dichlorodiphenyldichloroethane
DDE - dichlorodiphenyldichloroethene
DDT - dichlorodiphenyltrichloroethane
EDL - estimated detection limit (sample-specific)
IROD - Interim Record of Decision
m - meter(s)
MNR - monitored natural recovery
NA - not available, planned for but not reported due to various sampling or analytical reasons
ND - not detected
o,p - ortho or para position of chlorine on phenyl groups
PED - polyethylene device
pg/L - picograms per liter
SPME - solid-phase microextraction fibers

Notes
1. Analytical results for DDTs are shown in **picograms per liter (pg/L**, parts per quadrillion).
2. "DDTs" is the sum of six target DDT isomers (o,p'-DDD, o,p'-DDE, o,p'-DDT, p,p'-DDD, p,p'-DDE, and p,p'-DDT).
3. Results in parentheses (223) are replicate sample results. Parentheses with an asterisk (803)* are the higher of two triplicate results.
4. Shaded cells show DDTs greater than the IROD AWQC (ecological) of 1 nanogram per liter (ng/L) = 1,000 pg/L. The protectiveness of the 2009 IROD DDTs limits may be re-evaluated at the next 5-year review, as AWQC for individual DDT isomers were updated in 2015.
5. In calculating summations of DDTs, **non-detects were assumed to have a value of zero**.
6. Pumped samples were collected via tubing from selected depths; minimum sample volumes were 1,100 liters; samples were filtered; results were derived for both the dissolved-phase (filtrate) and the filter residue. DDTs were collected on a XAD-II resin column.

Sampling Events
1997 - Average of dissolved winter and summer sampling results from *In Situ Measurements of Chlorinated Hydrocarbons in the Water Column off the Palos Verdes Peninsula, California* (Zeng, 1999).
2010 - Passive sampling to measure background dissolved persistent organic pollutant concentrations in the water column of the Palos Verdes Shelf Superfund site (Fernandez et al., 2012). Results were recalculated using updated PED-water partitioning coefficients (K_{pew}) derived in the 2013 study (Appendix D of this report).
2013 - *Palos Verdes Shelf Water Column Passive Samplers Deployment: Data Summary* (Appendix D of this report)
2015 - High resolution grab water sampling

Table 4-5 - Comparison of PCBs in Water
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Nominal sample depth (m)		*Near-surface (-5 m)*		*Mid-column (~1/2 total depth)*			*Near-bottom (+5 m)*				*Bottom (+2 m)*		*Bottom (+1 m)*
Sample type		*PED*	*Grab*	*Pump*	*PED*	*Grab*	*Pump*	*PED*		*Grab*	*Pump*	*Grab*	*Pump*
Location	*Total Depth (m)*	*2013*	*2015*	*1997*	*2013*	*2015*	*1997*	*2010*	*2013*	*2015*	*1997*	*2015*	*1997*
BA1C	60	13	23		46	46		47	140	48		46	
BA3C	60	20	13 (19)		50	52		NA	93	28		28	310
BA4C	60	17	24		38	33		100	310	50		170	
BA5C	60	18	19		69	24		69	140	76		110 (140)	360
BA5DC	40	23	20		39	14		66	85	53		120 (110)	
BA6B	150		18			22				50			260
BA6C	60		43	110		65	445			94	455		550
BA6DC	40		19			15				140			
BA6D	30												410
BA7C	60	13	92		36	190		NA	130	27		5.2	420
BA7DC	40	15	11		24	58		51	62	100		88 (87)*	
BA8C	60	NA	3.8		31	24		49	27	63		39 (25)	
BA8DC	40	10	16		13	110		45	72	80		74	
BA9C	60	NA	12		13	41		21	32	25		31	160
BA9DC	40	12	42		13	70		31	24	49		7.4 (8.6)	
W1	60	4.6	6.5		16	29			26	16		11	
0C	60												170
W2	200	4.4	25		7.3	40			30	57		48	
W3	200	5.8	27		8.3	36			52	120		150	
W4	200	4.1	41		8.5	29			38	78		5.1	
W5	60	NA	5.0		NA	13			NA	3.9 (3.9)		15	
T11	60	1.5	1.3		1.0	6.8		4.0	2.1	0.52		0.51	

Abbreviations
AWQC - Ambient Water Quality Criteria
IROD - Interim Record of Decision
m - meters
MNR - monitored natural recovery
NA - not available
o,p - ortho or para position of chlorine on phenyl groups
PCB - polychlorinated biphenyl
PED - polyethylene device
pg/L - picograms per liter
PRC - performance reference compound
SPME - solid-phase microextraction

Notes
1. Analytical results for PCBs are in **picograms per liter (pg/L**, parts per quadrillion).
2. Concentrations of PCBs are summations of various congener lists (see Note 5).
3. Results in parentheses (140) are replicate sample results. Parentheses with an asterisk (87)* are the higher of two triplicate results.
4. Shaded cells show Total PCBs greater than the IROD AWQC (human health) of 0.064 nanograms per liter (ng/L) = 64 pg/L.
The protectiveness of the 2009 IROD PCBs limits may be re-evaluated at the next 5-year review.
5. In calculating summations of Total PCBs, **non-detects were assumed to have a value of zero**.
PED results include 44 PCB congeners (not including PCB 31, 195, 203; including PCB 200), and were PRC adjusted.
Grab results include 46 PCB congeners (not including PCB 200), adjusted with labeled isotopic standards.
Pump results include 27 PCB congeners; XAD-II resin column spiked by lab with labeled surrogates.
6. Pumped samples were collected via tubing from selected depths; minimum sample volumes were 1,100 liters; samples were filtered; results were derived for both the dissolved-phase (filtrate) and the filter residue.

Sampling Events
1997 - Average of dissolved winter and summer sampling results from *In Situ Measurements of Chlorinated Hydrocarbons in the Water Column off the Palos Verdes Peninsula, California* (Zeng, 1999).
2010 - *Passive sampling to measure background dissolved persistent organic pollutant concentrations in the water column of the Palos Verdes Shelf Superfund Site* (Fernandez et al., 2012). Results were recalculated using updated PED-water partitioning coefficients (K_{pew}) derived in the 2013 study (Appendix D of this report).
2013 - *Palos Verdes Shelf Water Column Passive Samplers Deployment: Data Summary* (Appendix D of this report).
2015 - High resolution grab sampling

Table 4-6 – Comparison of DDTs in Fish
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

	BSB									*WC*												
Sampling event	***NOAA 2002-2004 (ND = 0)***			***Sanitation Districts 2012 (ND = 0)***			***EPA 2014-2016 (ND = EDL)***			***NOAA 2002-2004 (ND = 0)***			***EPA ICs 2009-2012 (ND = MDL)***			***Sanitation Districts 2015 (ND = 0)***			***EPA 2014-2016 (ND = EDL)***		
Location	***Min***	***Avg***	***Max***	***Min***	***Avg***	***Max***	***Min***	***Avg***	***Max***	***Min***	***Avg***	***Max***	***Min***	***Avg***	***Max***	***Min***	***Avg***	***Max***	***Min***	***Avg***	***Max***
Breakwater Area	60,700	202,000 (6)	402,000				22,200	75,350 (31)	247,000	17,300	251,000 (49)	2,900,000	14,800	127,000 (15)	267,000				57,000	284,000 (30)	622,000
Huntington Flats	124,000	124,000 (1)	124,000				10,700	93,400 (30)	543,000	35,600	104,000 (10)	188,000									
Redondo Flats	45,300	99,100 (10)	269,000				8,770	54,500 (26)	153,000	60,100	234,000 (25)	874,000							79,800	222,000 (8)	508,000
Ventura Flats										44,200	84,000 (9)	115,000	10,300	25,200 (4)	48,300				4,490	11,800 (30)	21,300
Zone 1	46,200	882,000 (16)	4,320,000		127,000 (10)		17,600	286,000 (30)	701,000	186,000	1,350,000 (16)	6,770,000					2,850,000 (10)		157,000	765,000 (30)	2,360,000
Zone 2					70,000 (10)		39,200	136,000 (12)	371,000	127,000	992,000 (29)	3,590,000					1,550,000 (10)		110,000	773,000 (30)	2,030,000
Zone 3	65,400	303,000 (5)	586,000		65,000 (10)		13,400	96,900 (14)	250,000								875,000 (10)		81,700	417,000 (30)	1,530,000

Abbreviations
Avg - Average
BSB - Barred sand bass
COCs - Chemicals of concern
DDD - Dichlorodiphenyldichloroethane
DDE - Dichlorodiphenyldichloroethene
DDT - Dichlorodiphenyltrichloroethane
EDL - Estimated detection limit (sample specific)
EPA - United States Environmental Protection Agency
ICs - Institutional Controls
IROD - Interim Record of Decision
JWPCP - Joint Water Pollution Control Plant
m - Meters
Max - Maximum
MDL - Method detection limit
Min - Minimum
MNR - Monitored natural recovery
NA - Not applicable
ND - Not detected
NOAA - National Oceanic and Atmospheric Administration
NPDES - National Pollutant Discharge Elimination System
o,p - Ortho or para position of chlorine on phenyl groups
SCCWRP - Southern California Coastal Water Research Project
WC - White croaker

Notes
1. Concentrations of DDTs are in units of **picograms per gram (pg/g =** parts per trillion).
2. "DDTs" is the sum of six target DDT isomers (o,p'-DDD, o,p'-DDE, o,p'-DDT, p,p'-DDD, p,p'-DDE, and p,p'-DDT).
3. Numbers in parentheses are the numbers of fish results in each average calculation or composite.
4. NOAA 2002-2004 results are from fish caught at overlapping or adjacent locations: Segment 16 and EPA A (Breakwater Area); Segment 20 (Huntington Flats); Segments 6, 7, and EPA F (Redondo Flats); Segment 1 (Ventura Flats); Segments 12 and 13-14 (Zone 1); EPA E (Zone 2); and Segments 8 and 9 (Zone 3).
5. EPA 2014-2016 results are based on the current sampling program from the locations listed.
6. EPA ICs 2009-2012 results are from WC caught at adjacent pier locations: Long Beach Breakwall and Cabrillo Pier (Breakwater Area); and Santa Monica Pier (Ventura Flats reference area).
7. Sanitation Districts' 2012 results BSB and 2015 results for WC are from fish surveys typically conducted as part of JWPCP NPDES permit compliance. Those results are from analyses of composited samples of 10 fish specimens (one composite each from Zones 1, 2, and 3; Sanitation Districts, 2014, 2016).
8. Shaded cells show DDTs greater than the IROD human health goal for ingestion of WC (400 micrograms per kilogram = 400,000 pg/g).
9. EPA Zones 1, 2, and 3 are subareas within the boundaries of the respective Sanitation Districts' three Fish Tissue Bioaccumulation Zones used in the JWPCP NPDES compliance programs for fish. The EPA zones were located along the 60-m isobath, the depth of the outfall diffusers, the former source of release of COCs to the environment.

Sampling Events
NOAA 2002-2004 - Skin-off filet fish tissue results in *2002-2004 Southern California Coastal Marine Fish Contaminants Survey* (NOAA/EPA, 2007).
EPA ICs 2009-2012 - Institutional Controls program, skin-off filet results in Technical Memoranda - *Risk Evaluation of Fish Monitoring Results and Lobster Data* (Gilbane, 2016b), and *Human Health Risk Evaluation of 2011-2012 Fish Collection Data* (Gilbane, 2017), Palos Verdes Shelf.
Sanitation Districts 2012 - Skin-off filet results in *2012-2013 Joint Water Pollution Control Plant, Biennial Receiving Water Monitoring Report*, Table 7.3 2012 Local Seafood Safety Data Summary (Sanitation Districts, 2014).
Sanitation Districts 2015 - Skin-off filet results in *2014-2015 Joint Water Pollution Control Plant, Biennial Receiving Water Monitoring Report*, Appendix 7.17 2014-2015 Local Bioaccumulation Trends (Sanitation Districts, 2016).
EPA 2014-2016 - Skin-off filets for EPA's MNR event.

Table 4-7 − Comparison of PCBs in Fish
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

	BSB									WC											
Sampling event	***NOAA 2002-2004 (ND = 0)***			***Sanitation Districts 2012 (ND = 0)***			***EPA 2014-2016 (ND = EDL)***			***NOAA 2002-2004 (ND = 0)***			***EPA ICs 2009-2012 (ND = MDL)***			***Sanitation Districts 2015 (ND = 0)***			***EPA 2014-2016 (ND = EDL)***		
Location	***Min***	***Avg***	***Max***	***Min***	***Avg***	***Max***	***Min***	***Avg***	***Max***	***Min***	***Avg***	***Max***	***Min***	***Avg***	***Max***	***Min***	***Avg***	***Max***	***Min***	***Avg***	***Max***
Breakwater Area	24,300	57,400 (6)	111,000				4,240	17,800 (31)	77,300	5,260	44,200 (49)	279,000	23,600	82,500 (15)	164,000				10,600	52,000 (30)	87,400
Huntington Flats	80,300	80,300 (1)	80,300				7,680	43,800 (30)	171,000	5,410	41,100 (10)	72,400									
Redondo Flats	8,170	26,500 (10)	58,700				4,960	27,600 (26)	128,000	18,600	62,100 (25)	209,000							26,500	70,300 (8)	146,000
Ventura Flats										8,860	21,700 (9)	31,000	7,570	15,800 (4)	23,500				1,340	2,820 (30)	5,140
Zone 1	5,470	97,800 (16)	294,000		67,000* (10)		6,460	34,800 (30)	106,000	24,800	348,000 (16)	619,000					267,000 (10)		40,500	82,200 (30)	199,000
Zone 2					31,000* (10)		3,770	22,700 (12)	66,000	15,300	120,000 (29)	356,000					154,000 (10)		24,700	115,000 (30)	256,000
Zone 3	12,100	40,400 (5)	80,400		17,000* (10)		4,190	16,100 (14)	38,500								86,100 (10)		9,980	50,700 (30)	164,000

<u>Abbreviations</u>
Avg - Average
BSB - Barred sand bass
COCs - Chemicals of concern
EDL - Estimated detection limit (sample-specific)
EPA - United States Environmental Protection Agency
ICs - Institutional Controls
IROD - Interim Record of Decision
m - Meters
Max - Maximum
MDL - Method detection limit
Min - Minimum
MNR - Monitored natural recovery
NA - Not applicable
ND - Not detected
NOAA - National Oceanic and Atmospheric Administration
PCBs - Polychlorinated biphenyls
WC - White croaker

<u>Notes</u>
1. Concentrations of PCBs are in units of **picograms per gram (pg/g =** parts per trillion).
2. Different researchers used different congener lists. Sanitation Districts 2012 BSB results are for total detectable Aroclors*. See reference documents.
3. Numbers in parentheses are the numbers of fish results in each average calculation or composite.
4. NOAA 2002-2004 results are from fish caught at overlapping or adjacent locations: Segment 16 and EPA A (Breakwater Area); Segment 20 (Huntington Flats); Segments 6, 7, and EPA F (Redondo Flats); Segment 1 (Ventura Flats); Segments 12 and 13-14 (Zone 1); EPA E (Zone 2); and Segments 8 and 9 (Zone 3).
5. EPA 2014-2016 results are based on the current sampling program from the locations listed.
6. EPA ICs 2009-2012 results are from WC caught at adjacent pier locations: Long Beach Breakwall and Cabrillo Pier (Breakwater Area); and Santa Monica Pier (Ventura Flats reference area).
7. Sanitation Districts' 2012 results BSB and 2015 results for WC are from fish surveys typically conducted as part of JWPCP NPDES permit compliance. Those results are from analyses of composited samples of 10 fish specimens (one composite each from Zones 1, 2, and 3; Sanitation Districts, 2014, 2016).
8. Shaded cells show Total PCBs greater than the IROD human health goal for ingestion of WC (70 micrograms per kilogram = 70,000 pg/g).
9. EPA Zones 1, 2, and 3 are subareas within the boundaries of the respective Sanitation Districts' three Fish Tissue Bioaccumulation Zones used in the JWPCP NPDES compliance programs for fish. The EPA zones were located along the 60-m isobath, the depth of the outfall diffusers (the former source of release of COCs to the environment).

<u>Sampling Events</u>
NOAA 2002-2004 - Skin-off filet fish tissue results in *2002-2004 Southern California Coastal Marine Fish Contaminants Survey* (NOAA/EPA, 2007)
EPA ICs 2009-2012 - Institutional Controls program, skin-off filet results in *Technical Memorandum - Risk Evaluation of Fish Monitoring Results and Lobster Data* (Gilbane, 2016b), and *Technical Memorandum - Human Health Risk Evaluation of 2011-2012 Fish Collection Data - Palos Verdes Shelf* (Gilbane, 2017).
Sanitation Districts 2012 - Skin-off filet results in *2012-2013 Joint Water Pollution Control Plant, Biennial Receiving Water Monitoring Report*, Table 7.3 2012 Local Seafood Safety Data Summary (Sanitation Districts, 2014).
Sanitation Districts 2015 - Skin-off filet results in *2014-2015 Joint Water Pollution Control Plant, Biennial Receiving Water Monitoring Report*, Appendix 7.17 2014-2015 Local Bioaccumulation Trends (Sanitation Districts, 2016).
EPA 2014-2016 - Skin-off filets for EPA's MNR event

Table 5-1 - Summary of IROD Compliance
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

	IROD estimated value	*Representative value*	*IROD post-capping goal*	*IROD interim cleanup level*	*IROD final cleanup level*
Sediment (average concentrations)					
***Total DDTs* (mg/kg OC)**	150	77	78	46	23
***Total PCBs - short list* (mg/kg OC)**	-	5	7	7	-
***Total PCBs* (mg/kg OC)**	-	10	-	-	-
Water (human health)					
***p,p'-DDE* (ng/L)**	-	1.1	-	0.22	-
***Total PCBs* (ng/L)**	1.1	0.19	-	0.064	-
Water (ecological)					
***Total DDTs* (ng/L)**	16	1.6	-	1	-
***Total PCBs* (ng/L)**	1.1	0.19	-	30	-
White croaker - Zone 1 Collection Area					
***Total DDTs* (ug/kg)**	33,000	1,000	-	400	-
***Total PCBs* (ug/kg)**	3,000	98	-	70	-
White croaker - Zone 2 Collection Area					
***Total DDTs* (ug/kg)**	8,600	940	-	400	-
***Total PCBs* (ug/kg)**	920	130	-	70	-
White croaker - Zone 3 Collection Area					
***Total DDTs* (ug/kg)**	4,200	520	-	400	-
***Total PCBs* (ug/kg)**	190	60	-	70	-

Abbreviations

IROD - Interim Record of Decision
mg/kg OC - milligrams per kilogram normalized for organic carbon
ug/kg - micrograms per kilogram (parts per billion)
ng/L - nanograms per liter (parts per trillion)

Notes

1. For Total PCBs, all values are for the expanded list of congeners (46), unless otherwise noted.
2. For sediment, all values are for the 0-8-cm bed-depth interval (the bioactive zone at PV Shelf). The representative values are from the current output of the geostatistical model.
3. For water, the representative values are maximum concentrations from the current MNR data set. The representative values for p,p'-DDE and for Total DDTs are from the near-bottom sample for location 4C, and the representative value of Total PCBs is from the mid-column sample at location 7C.
4. For white croaker, the representative value for each collection area is the exposure point concentration based on the current data set.
5. The IROD estimated values were published in Section 5.0 of the IROD as being representative of site

Table 7-1 — Members of the Palos Verdes Technical Information Exchange Group
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Name	***Organization***	***E-mail address***
Anijielo, Augustine	Regional Water Quality Control Board, Los Angeles Region (Water Board)	aanijielo@waterboards.ca.gov
Boyce, Jennifer	National Oceanic and Atmospheric Administration (NOAA)	jennifer.boyce@noaa.gov
Chesnutt, John	United States Environmental Protection Agency (EPA)	chesnutt.john@epa.gov
Cordero, Daniel	California Department of Toxic Substances Control (DTSC)	daniel.cordero@dtsc.ca.gov
Delaplaine, Mark	California Coastal Commission	mdelaplaine@coastal.ca.gov
Dickhudt, Pat	United States Geological Survey (USGS) Woods Hole	pdickhudt@usgs.gov
Ford, Tom	Santa Monica Bay Restoration Commission (SMBRC)	tford@santamonicabay.org
Glaser, David	Anchor QEA	dglaser@anchorqea.com
Gold, Mark	UCLA IOES	gold@ioes.ucla.edu
Gully, Joe	Sanitation Districts of Los Angeles County (Sanitation Districts)	jgully@lacsd.org
Hovel, Wendy	Anchor QEA Irvine	whovel@anchorqea.com
Huang, Judy	EPA	Huang.Judy@epa.gov
Jirik, Andrew	Port of Los Angeles (POLA)	ajirik@portla.org
Joab, Bruce	California Department of Fish and Wildlife (CDFW)	bjoab@OSPR.DFG.CA.GOV
Klasing, Susan	California Office of Environmental Health Hazard Assessment (OEHHA)	Susan.Klasing@oehha.ca.gov
Lindfors, Robert	Gilbane	rlindfors@gilbaneco.com
Little, Annie	United States Fish and Wildlife Service (USFWS)	annie_little@fws.gov
Loretta Fernandez	Fluen Point Environmental	l.fernandez@neu.edu
Lowe, Chris	California State University Long Beach (CSULB)	chris.lowe@csulb.edu
Markle, Phil	Sanitation Districts	PMarkle@lacsd.org>
Maruya, Keith	Southern California Coastal Water Research Project (SCCWRP)	keithm@sccwrp.org
Munakata, Naoko	Sanitation Districts	NMunakata@lacsd.org
Murray, Dana	Heal the Bay	dmurray@healthebay.org
Nguyen, Thanhloan	Water Board	thanhloan.nguyen@waterboards.ca.gov
Orrala, Frankie	Heal the Bay	forrala@healthebay.org
Power, Bill	Sanitation Districts	BPower@lacsd.org
Prickett, Kat	POLA	kprickett@portla.org
Roberts, Carole	US Fish and Wildlife	Carole_A_Roberts@fws.gov
Schiff, Ken	SCCWRP	Kens@sccwrp.org
Sherwood, Christopher	USGS Woods Hole	csherwood@usgs.gov
Tang, Chi-Li	LA County Sanitation Districts	ctang@lacsd.org
Trombadore, Olivia	EPA	trombadore.olivia@epa.gov
Tsao, Allen	Cal Fish and Wildlife	Allen.Tsao@wildlife.ca.gov
Velez, Patty	CDFW	pvelez@OSPR.DFG.CA.GOV
Vernon, James	Port of Long Beach (POLB)	james.vernon@polb.com
Wang, Guang-yu	SMBRC	Gwang@waterboards.ca.gov
Witting, David	NOAA	David.Witting@noaa.gov
Zeeman, Katie	USFWS	Katie_Zeeman@fws.gov

Table 7-2 — Associated Organizations
First MNR Report
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Organization	***Location***	***Primary contact***	***Function***
ALS Life Sciences Division|Environmental	Burlington, Ontario, Canada	Rachel Stolys	High resolution analysis of water samples
CDM Smith	Wayne, Pennsylvania	Aaron Frantz	Geostatistical modeling of sediment results
Eurofins Calscience Laboratories, Inc.	Garden Grove, California	Carla Hollowell	Chemical analysis of sediment samples
Fluen Point Environmental	Marblehead, Massachusetts	Loretta Fernandez	Water sampling using passive sampling devices
GMU Geotechnical, Inc.	Rancho Santa Margarita, California	Michael Moscrop, P.E.	Geotechnical analysis of sediment samples
Kinnetic Laboratories, Inc.	Carlsbad, California	Tim Fleming	Collection of grab water samples
National Oceanic and Atmospheric Administration	Long Beach, California	Dave Witting, Ph.D.	Design of fish collection grid
Sanitation Districts of Los Angeles County	Whittier, California	Chi-Li Tang	Collection of samples: sediment, water, and fish
Seaventures	San Juan Capistrano, California	Bob Lohrman	Collection of fish
Veridian Environmental, Inc.	Vacaville, California	Tracy Young	Data validation
Vista Analytical Laboratory	El Dorado Hills, California	Martha Maier	Preparation and analysis of fish samples

FIGURES

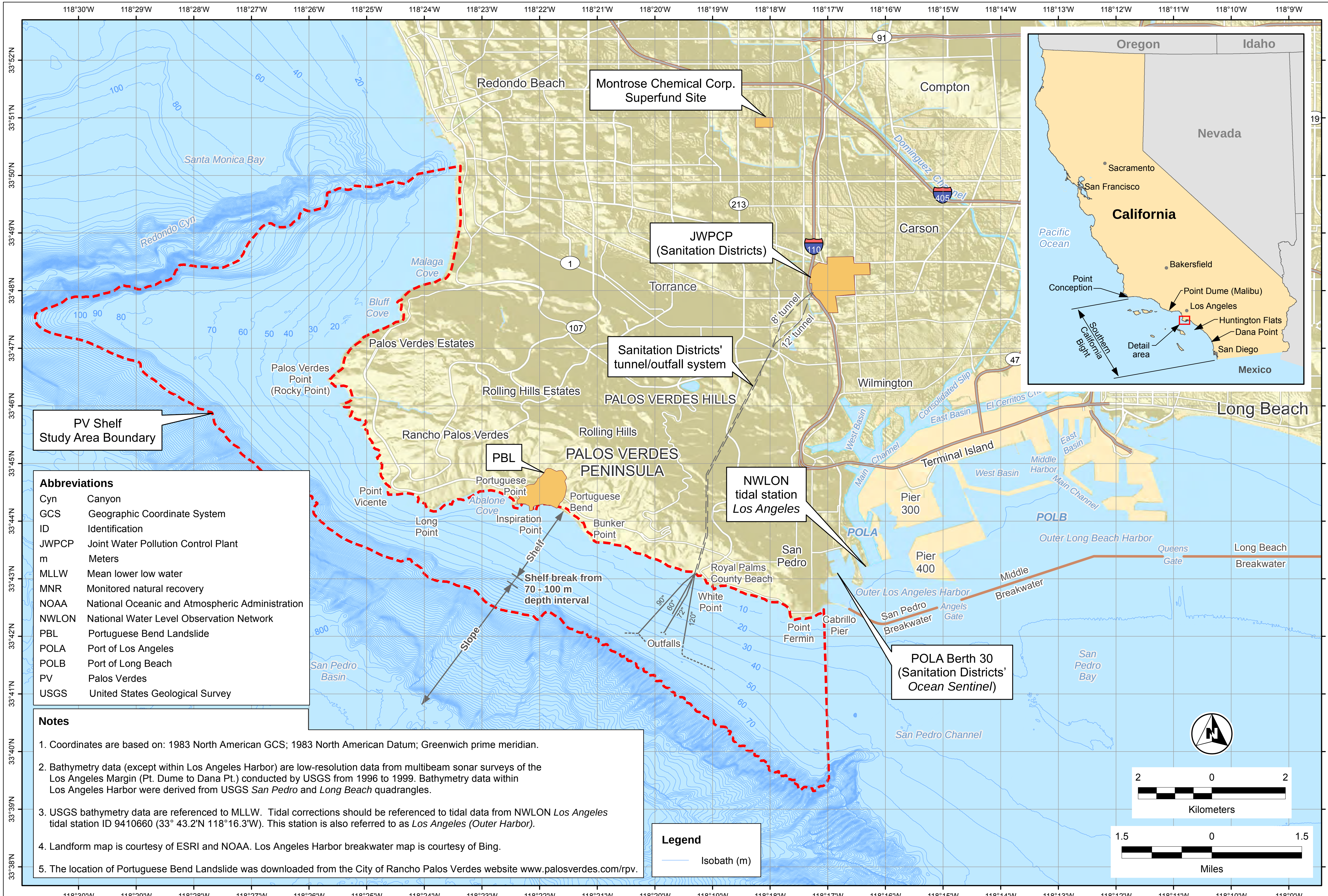
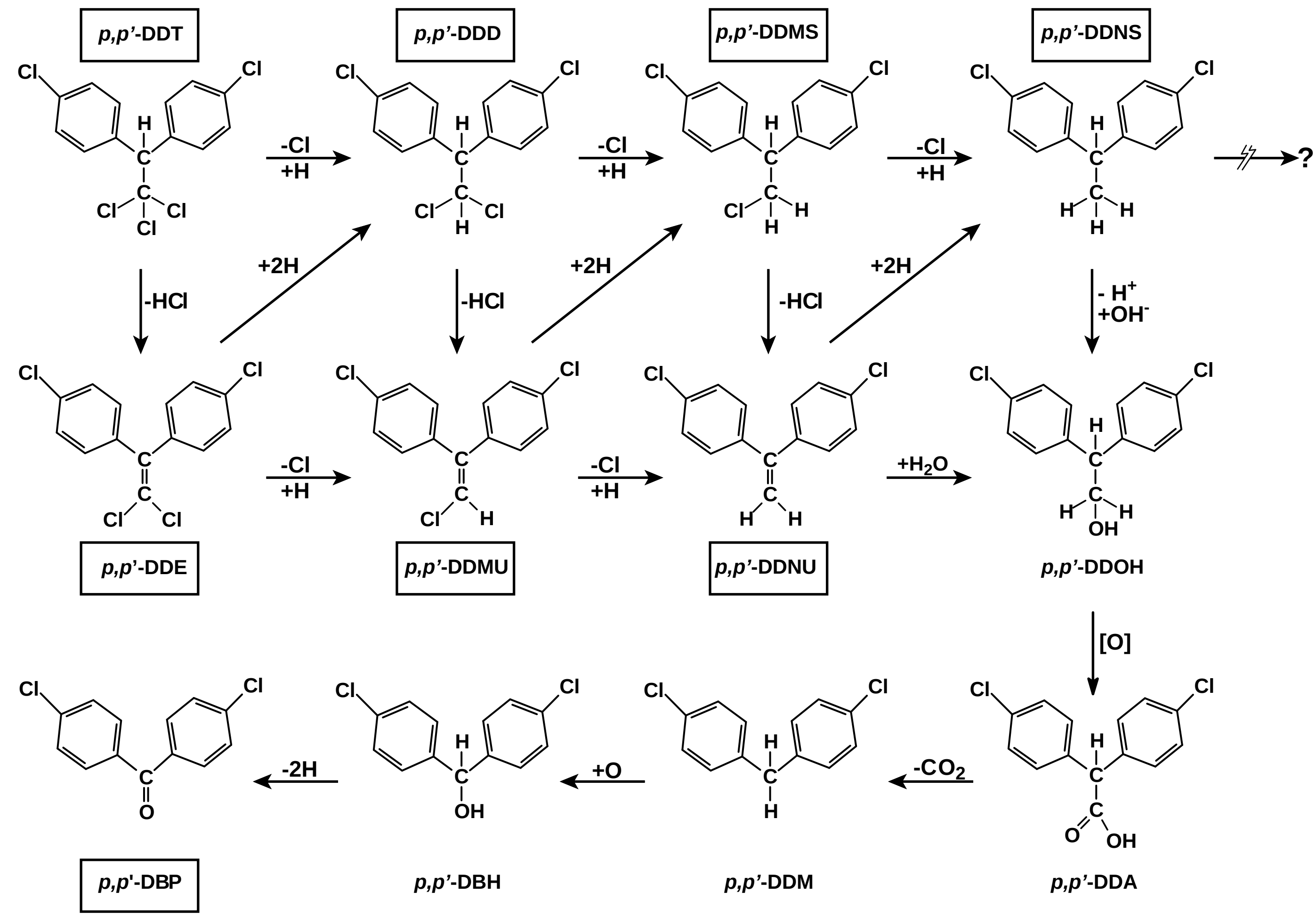


FIGURE 1-1
Location Maps – Palos Verdes Shelf

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

United States Environmental Protection Agency



Abbreviations

C	Carbon	p,p'-DDD	1-chloro-4-[2,2-chloro-1-1(4-chlorophenyl)ethyl]benzene
CO_2	Carbon dioxide	p,p'-DDE	1-chloro-4-[2,2-chloro-1-[4-chlorophenyl)ethenyl]benzene
Cl	Chlorine	p,p'-DDM	1-chloro-4-[1-(4-chlorophenyl)methyl]benzene
H	Hydrogen	p,p'-DDMS	1-chloro-4-[2-chloro-1-(4-chlorophenyl)ethyl]benzene
HCl	Hydrochloric acid	p,p'-DDMU	1,1-bis(4-chlorophenyl)-2-chloroethene
O	Oxygen	p,p'-DDNS	1-chloro-4-[1-(4-chlorophenyl)ethyl]benzene
OH	Hydroxide	p,p'-DDNU	1,1-bis(4-chlorophenyl)ethene
p,p'-DBH	Bis(4-chlorophenyl)methanol	p,p'-DDOH	2,2-bis(4-chlorophenyl)ethanol
p,p'-DBP	Bis(4-chlorophenyl)methanone	p,p'-DDT	1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane
p,p'-DDA	2,2-bis(4-chlorophenyl)acetic acid		

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

P:\EPAR9\0069 TO 068-RARA-09CA PV Shelf RA\13.0 Graphics\Chemical_Pathways.ai 09/21/2017

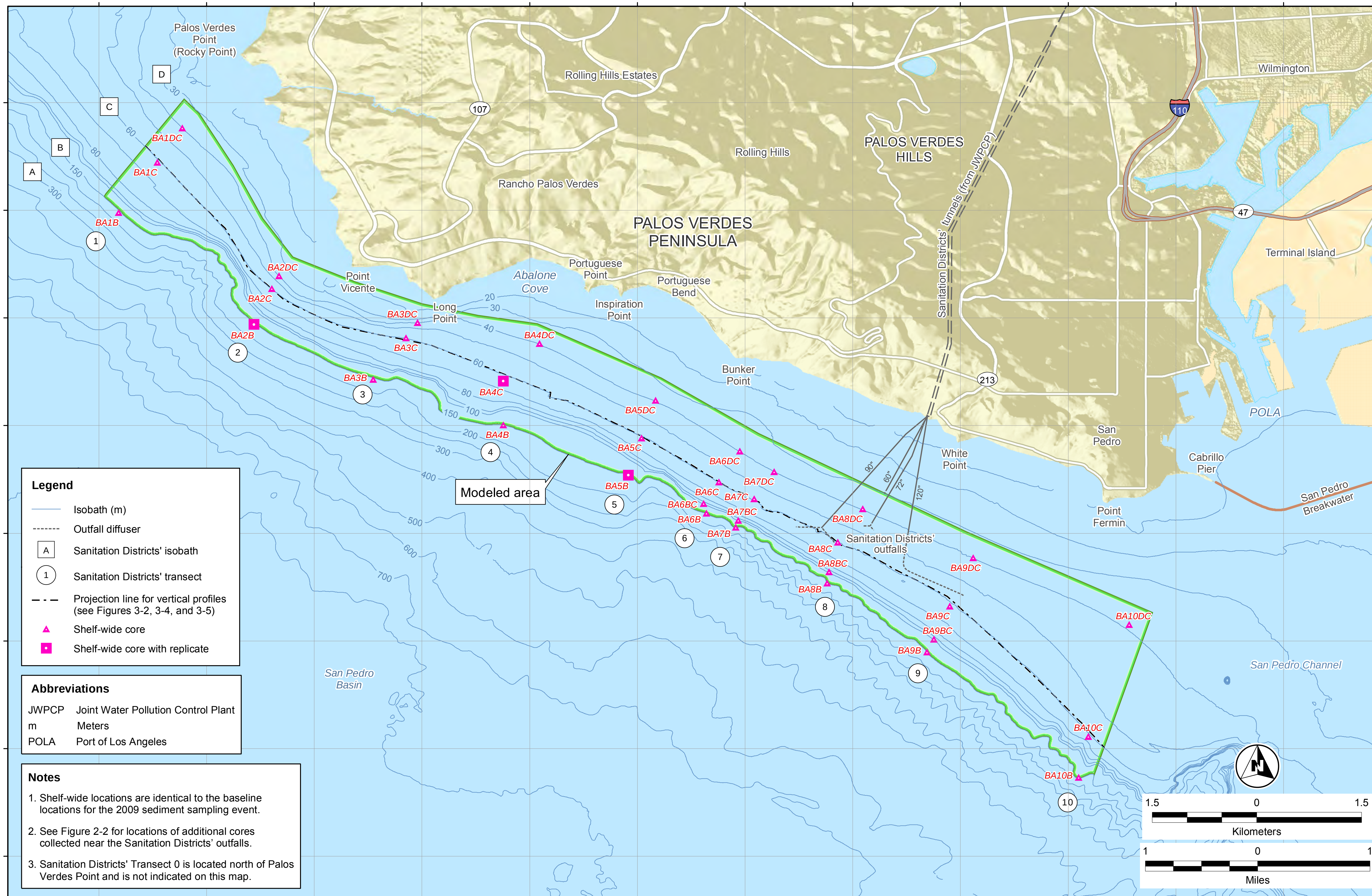


FIGURE 2-1
Sample Grid - Shelf-Wide Cores

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

EPA United States Environmental Protection Agency

G:\ArcGIS\EPA\Palos_Verdes_Shelf\PROJECTS\MNR2017\PV_Shelf_Sample_Locs_FSP_Oct2009_wide.mxd 4/17/2018 EANDERSON, Gilbane

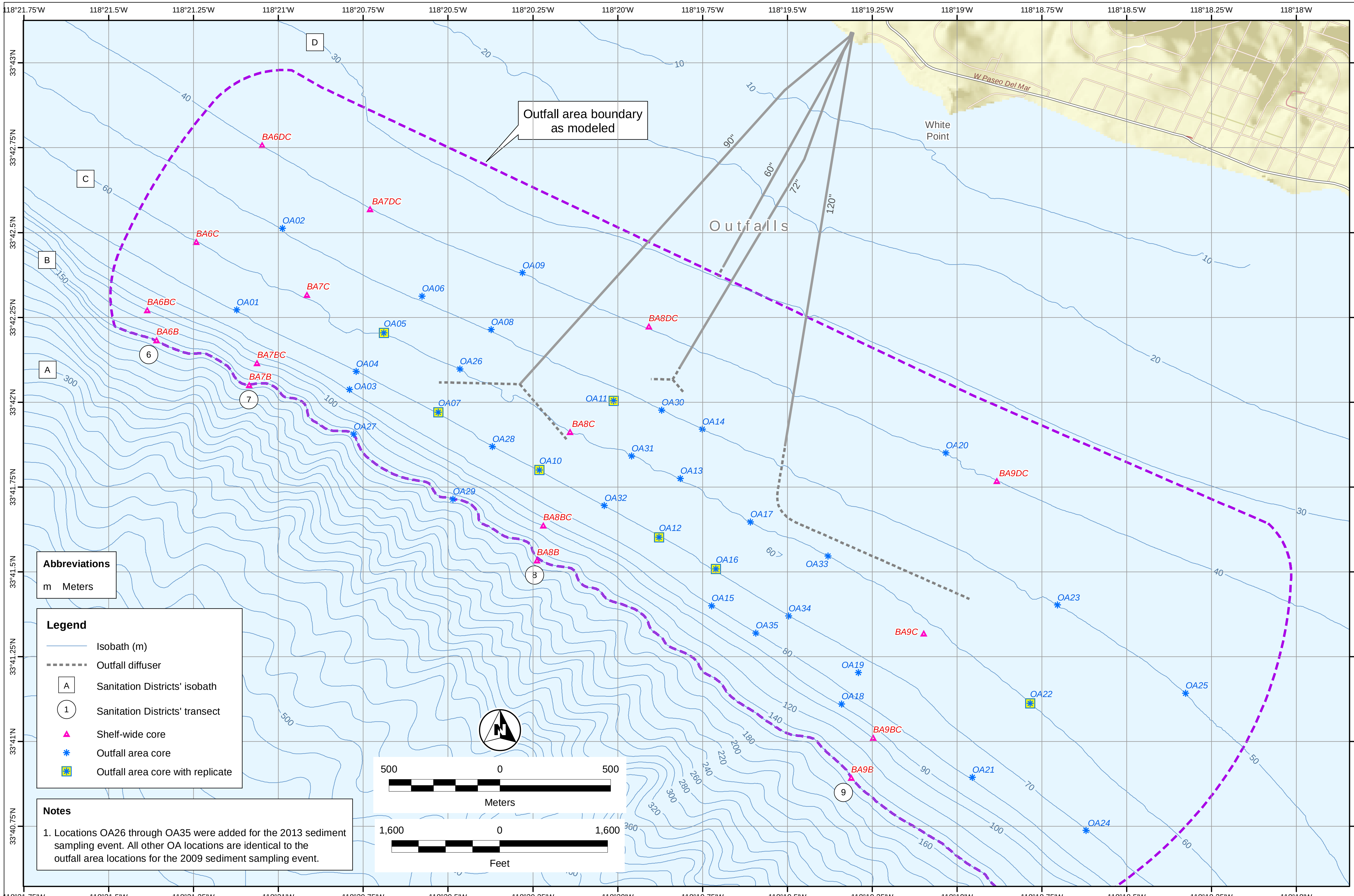
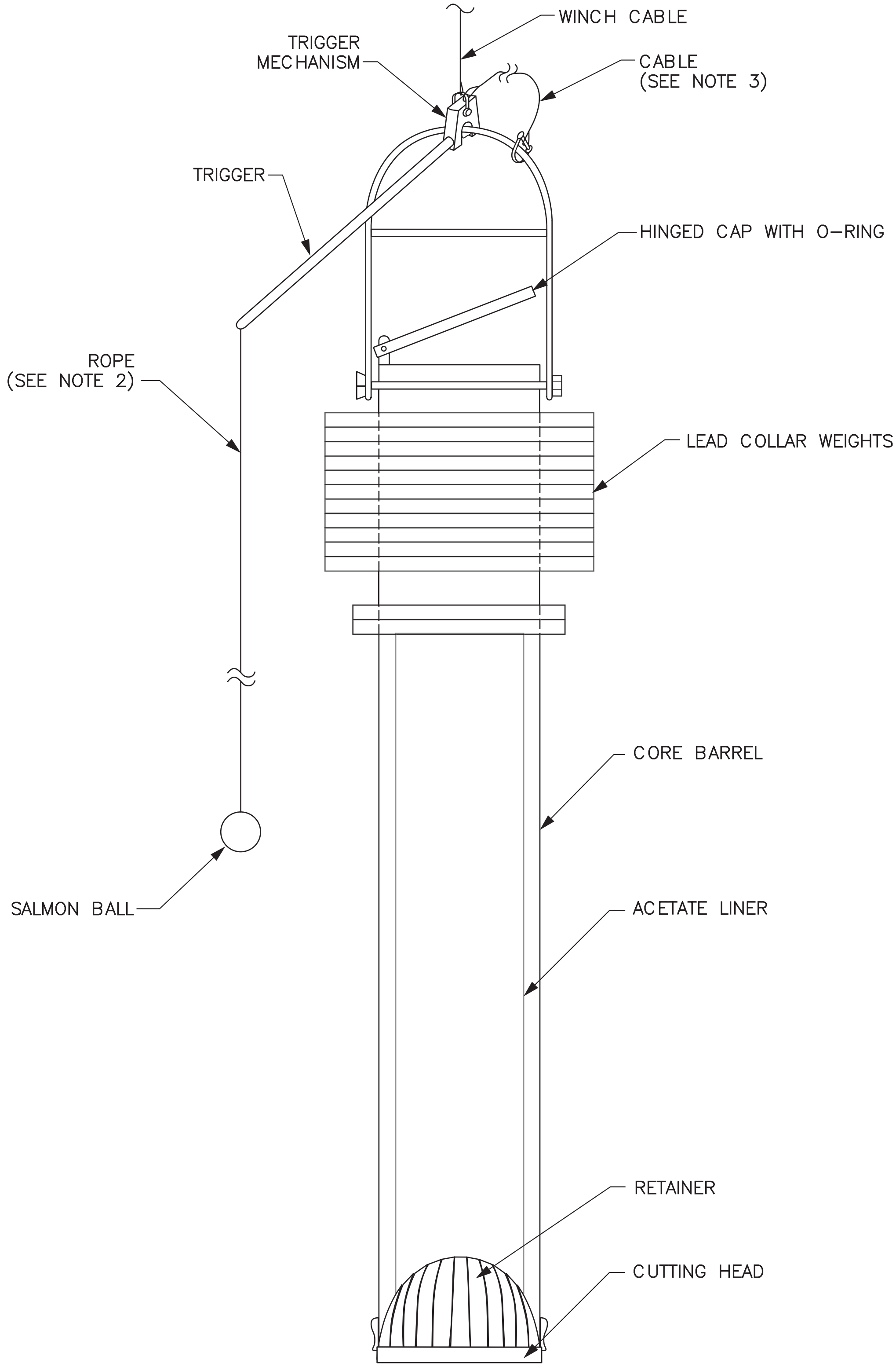


FIGURE 2-2
Sample Grid - Outfall Area Cores

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

United States Environmental Protection Agency
EPA



Notes

1. 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.
2. 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.
3. The cable keeps the trigger and core assembly attached after the trigger mechanism has fired.
4. Digital camera and inclinometer are not shown in this schematic.

P:\EPAR9\0069 TO 068-RARA-09CA PV Shelf RA\13.0 Graphics\Gravity_Corer.ai 08/23/2017

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First MNR Report
Palos Verdes Shelf
Los Angeles County, California

FIGURE 2-3
Schematic of
Gravity Corer

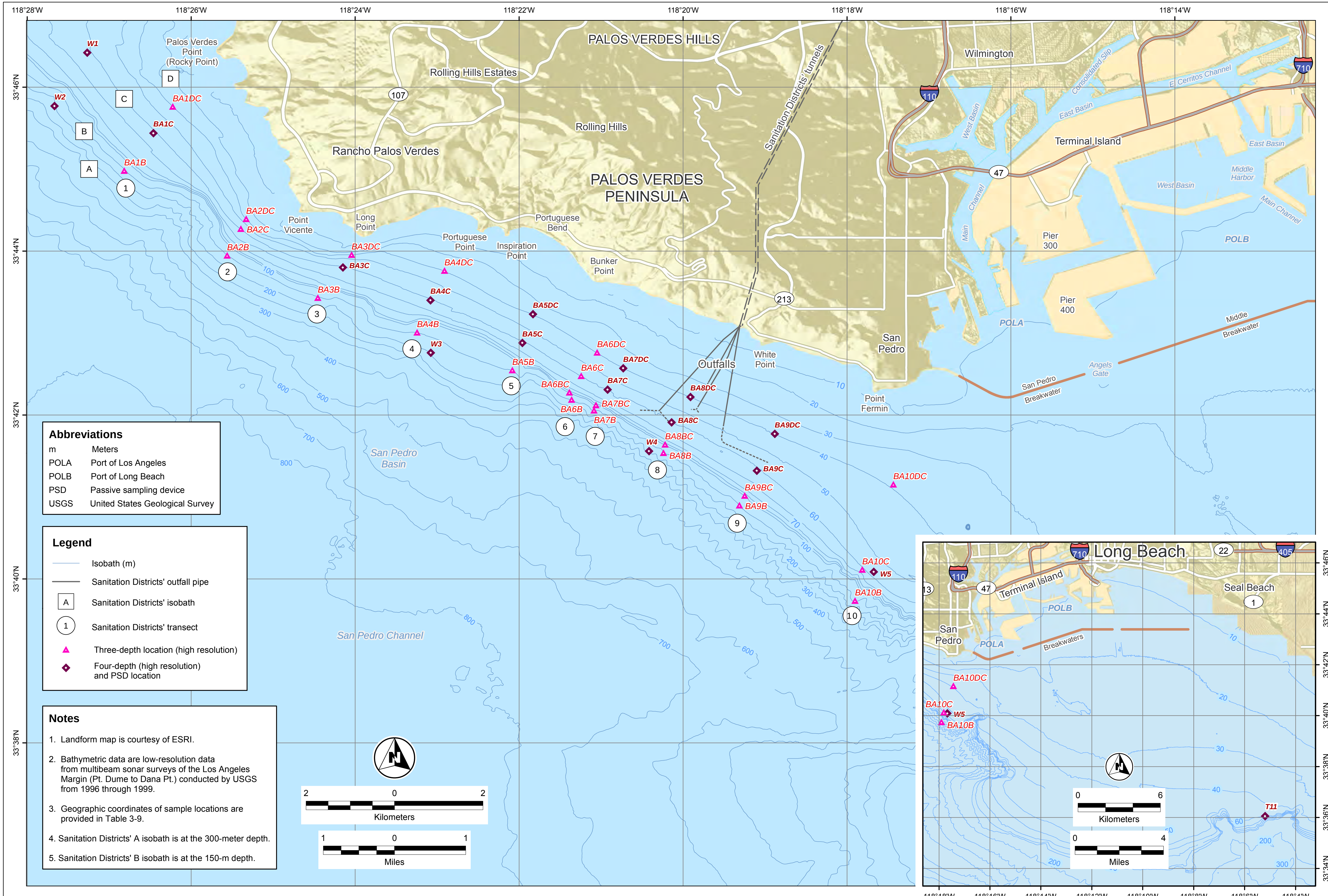

FIGURE 2-4
Grid for Water Samples

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

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G:\ArcGIS\EPA\Palos_Verdes_Shelf\PROJECTS\MNR2017\Grab_Wtr_SL.mxd 4/2/2018 eanderson, Gilbane

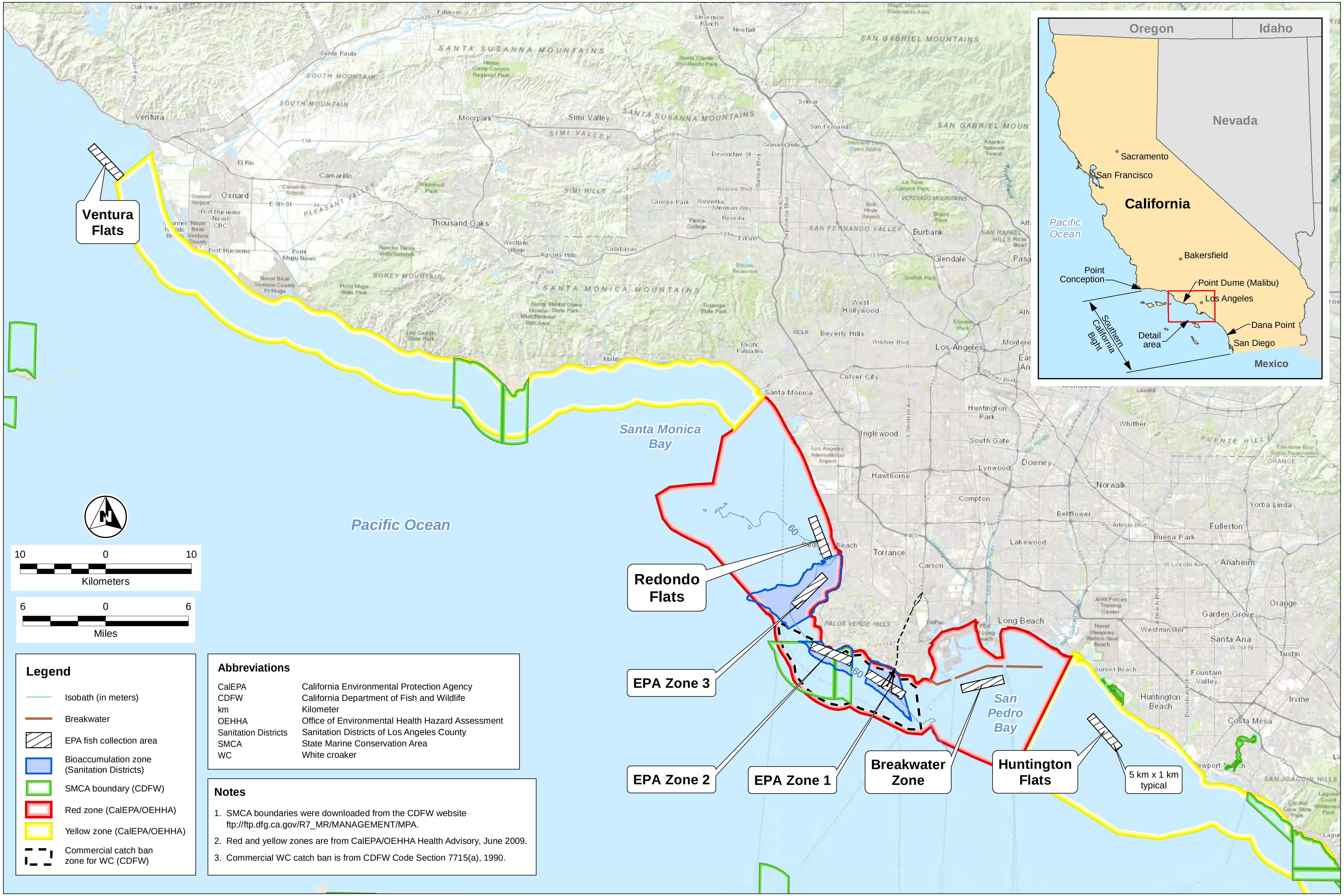
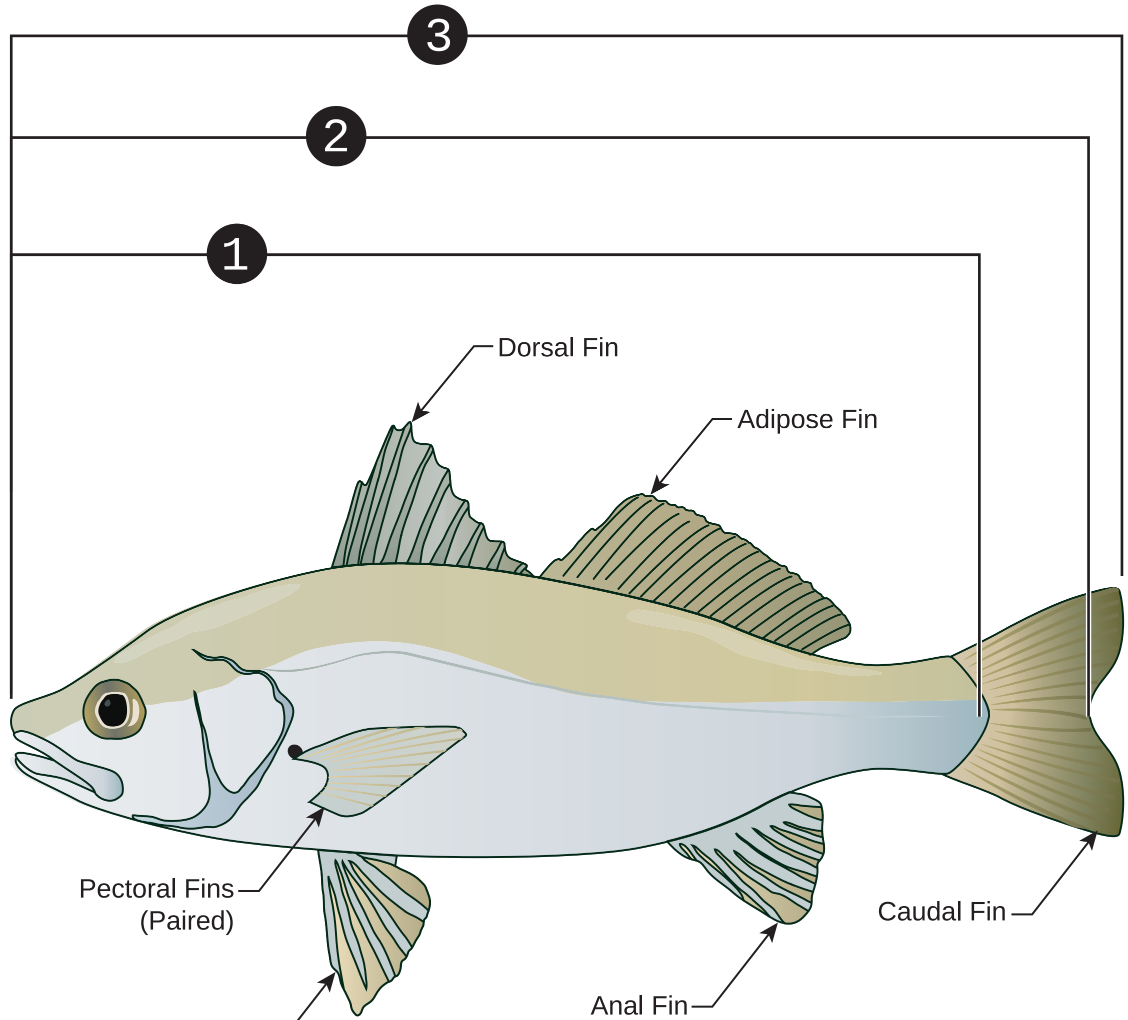


FIGURE 2-5
Fish Collection Areas

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

United States Environmental Protection Agency

G:\ArcGIS\EPA\Palos_Verdes_Shelf\PROJECTS\MNR2017\Fish_Collection_Areas.mxd 4/17/2018 eanderson, Gilbane



1 Standard length

2 Fork length

3 Total length

P:\EPAR9\0069 TO 068-RARA-09CA PV Shelf RA13.0 Graphics\Fish_Measurement.ai 08/15/2017

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First MNR Report
Palos Verdes Shelf
Los Angeles County, California

FIGURE 2-6
Typical Measurements of Fish Lengths

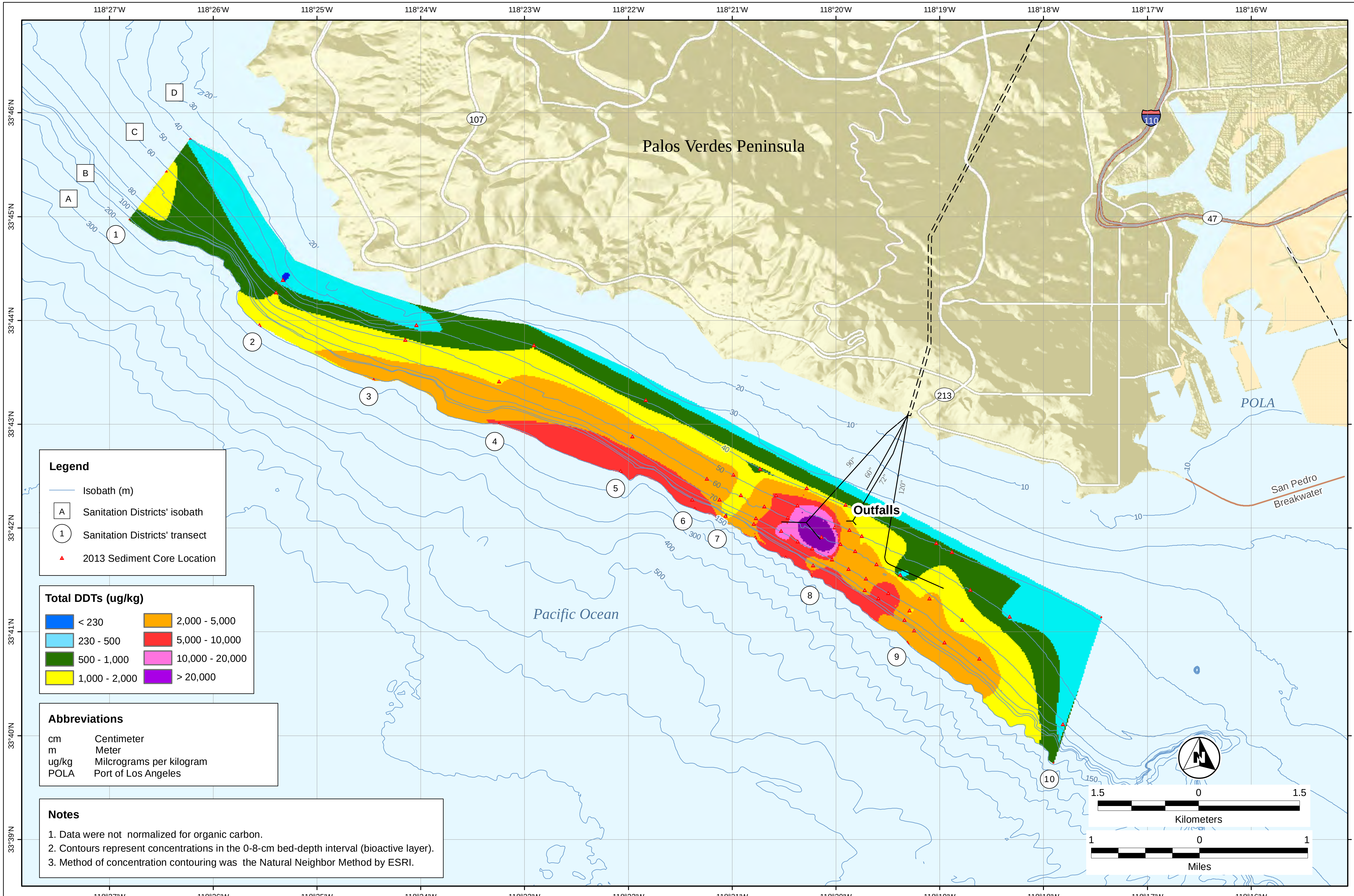


FIGURE 3-1
Concentration Contours of Total DDTs in Sediment

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

United States Environmental Protection Agency
EPA

G:\ArcGIS\EPA\Palos_Verdes_Shelf\PROJECTS\MNR2017\DDT_0_8cm.mxd 4/17/2018 eanderson, Gilbane

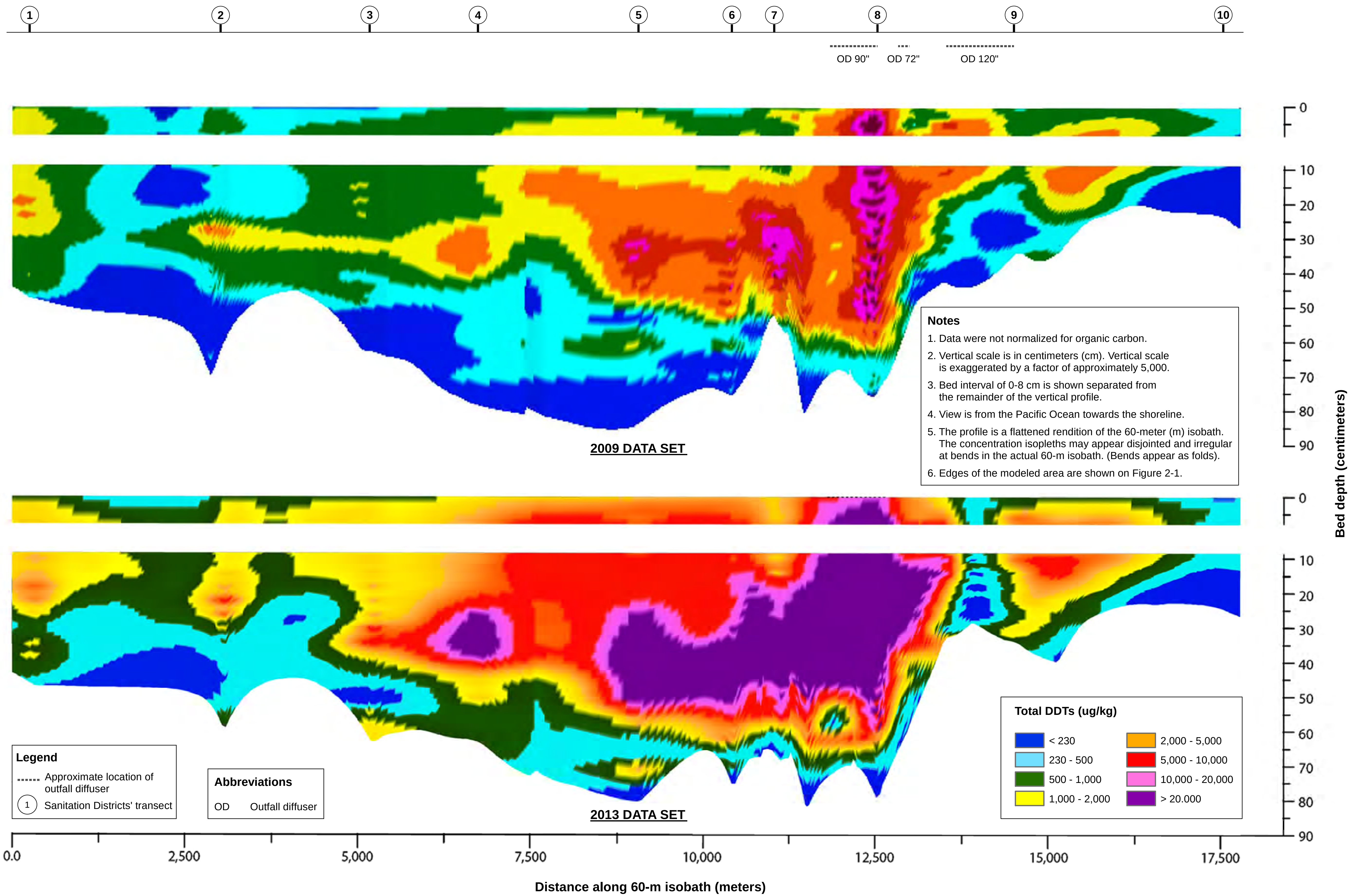


FIGURE 3-2
Vertical Profiles:
Total DDTs in Sediment

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

United States Environmental Protection Agency
EPA

G:\ArcGIS\EPA\Palos_Verdes_Shelf\PROJECTS\MNR2017\DDT_Vert.mxd 4/10/2018 eanderson, Gilbane

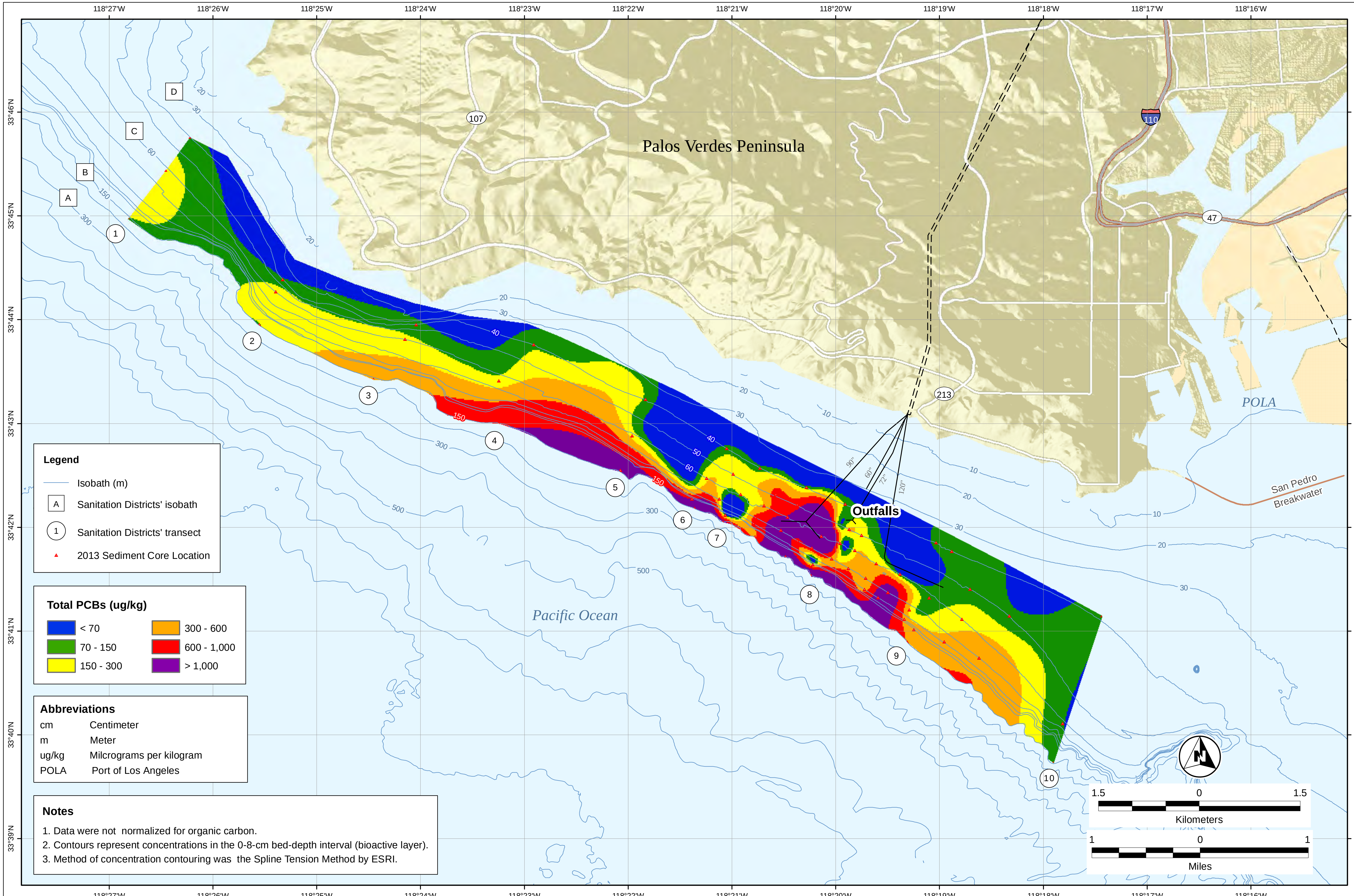


FIGURE 3-3
Concentration Contours of Total PCBs in Sediment (Short List)

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

United States Environmental Protection Agency
EPA

G:\ArcGIS\EPA\Palos_Verdes_Shelf\PROJECTS\MNR2017\PCB_0_8cm_ShortL.mxd 4/16/2018 EANDERSON, Gilbane

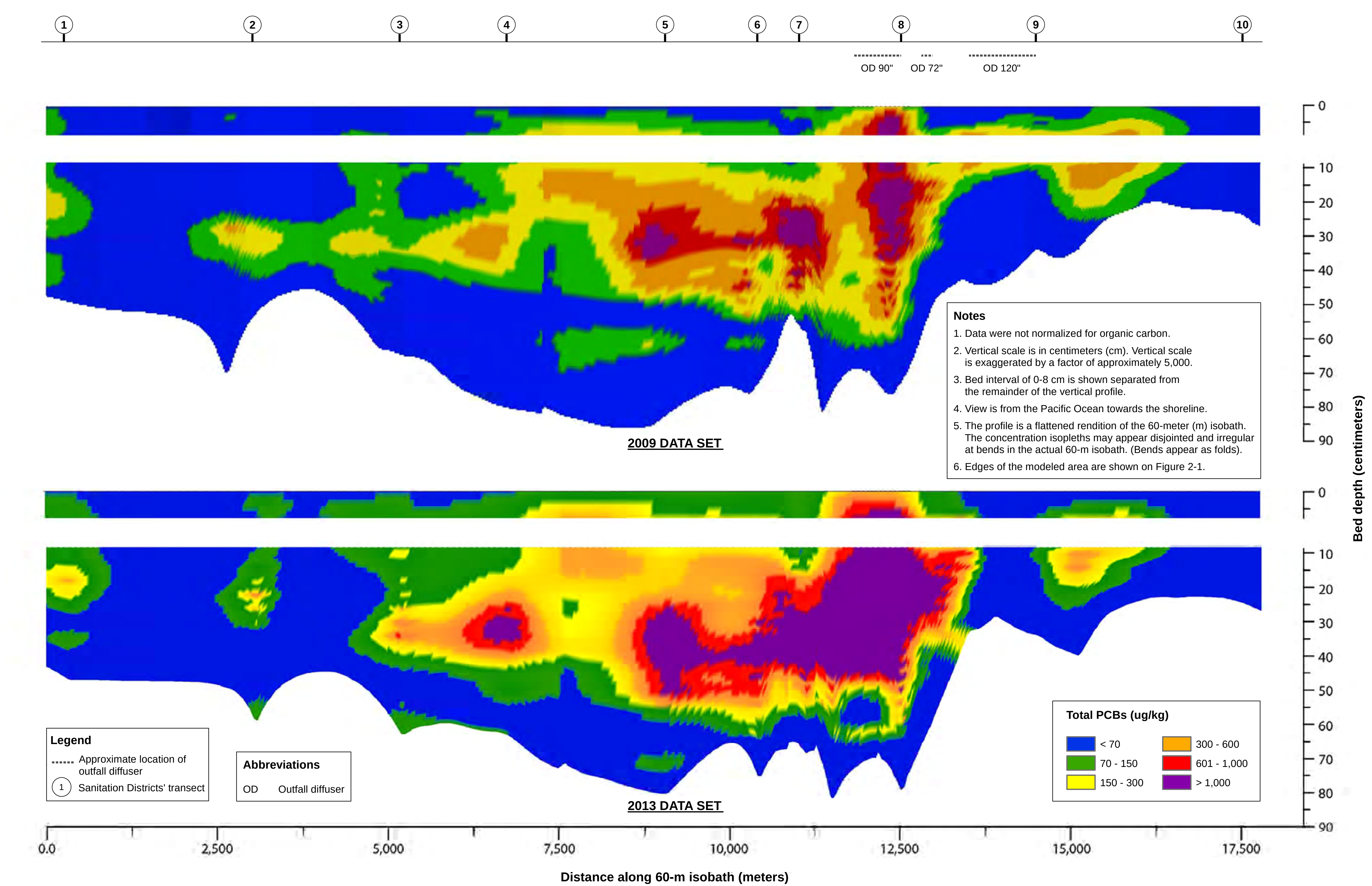


FIGURE 3-4
Vertical Profiles:
Total PCBs in Sediment
(Short List)

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

EPA United States Environmental Protection Agency

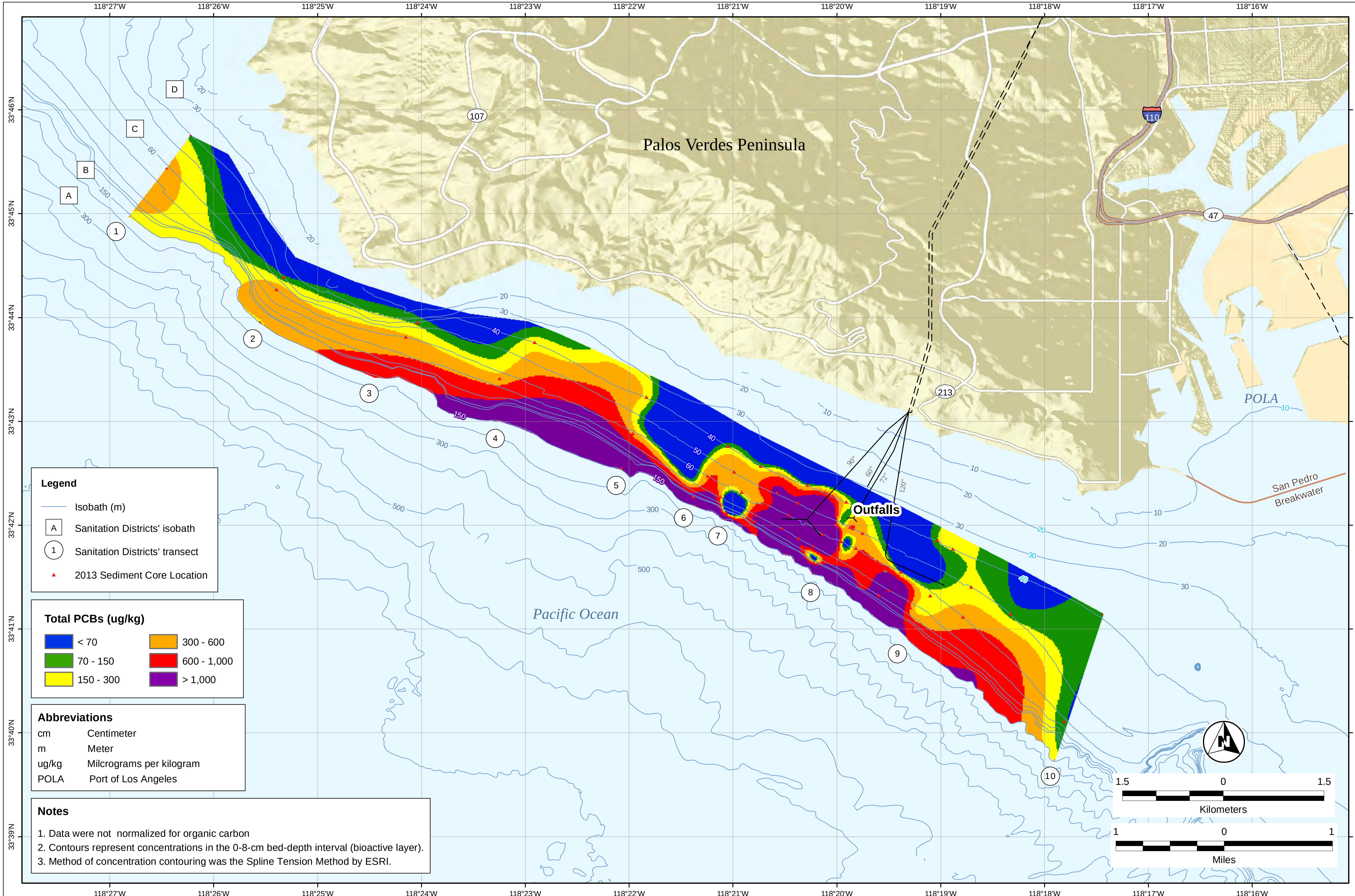


FIGURE 3-5
Concentration Contours of Total PCBs in Sediment (Expanded List)

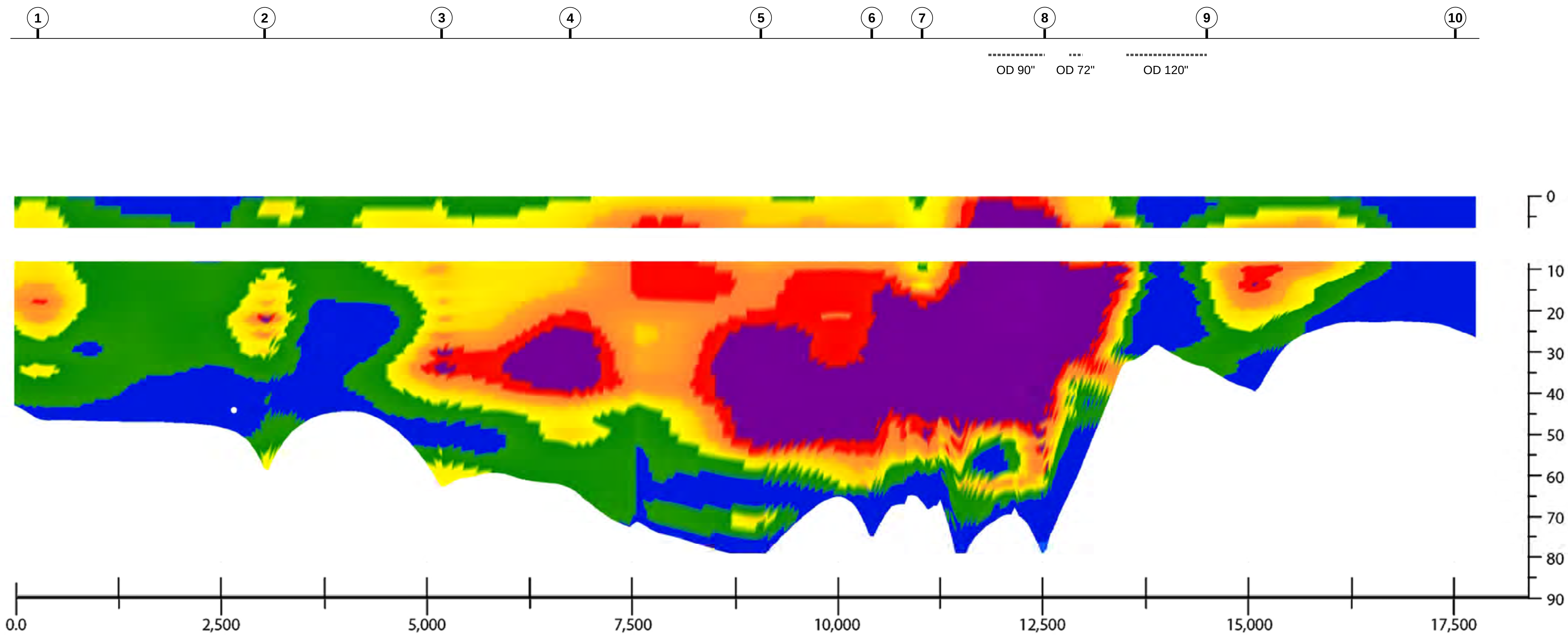
First MNR Report
Palos Verdes Shelf
Los Angeles County, California

EPA United States Environmental Protection Agency

G:\ArcGIS\EPA\Palos_Verdes_Shelf\PROJECTS\MNR2017\PCB_0_8cm_ExpndL.mxd 4/16/2018 EANDERSON, Gilbane

FIGURE 3-6
Vertical Profile:
Total PCBs in Sediment
(Expanded List)

First MNR Report
Palos Verdes Shelf
Los Angeles County, California



Abbreviations

OD Outfall diffuser

Legend

- - - - - Approximate location of outfall diffuser

(1) Sanitation Districts' transect

Total PCBs (ug/kg)

< 70	301 - 600
70 - 150	601 - 1,000
151 - 300	> 1,000

Notes

1. Data were not normalized for organic carbon.
2. Vertical scale is in centimeters (cm). Vertical scale is exaggerated by a factor of approximately 5,000.
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-meter (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 modeled area are shown on Figure 2-1.

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G:\ArcGIS\EPA\Palos_Verdes_Shelf\PROJECTS\MNR2017\PCB_ExpndL_Vert.mxd 4/10/2018 eanderson, Gilbane

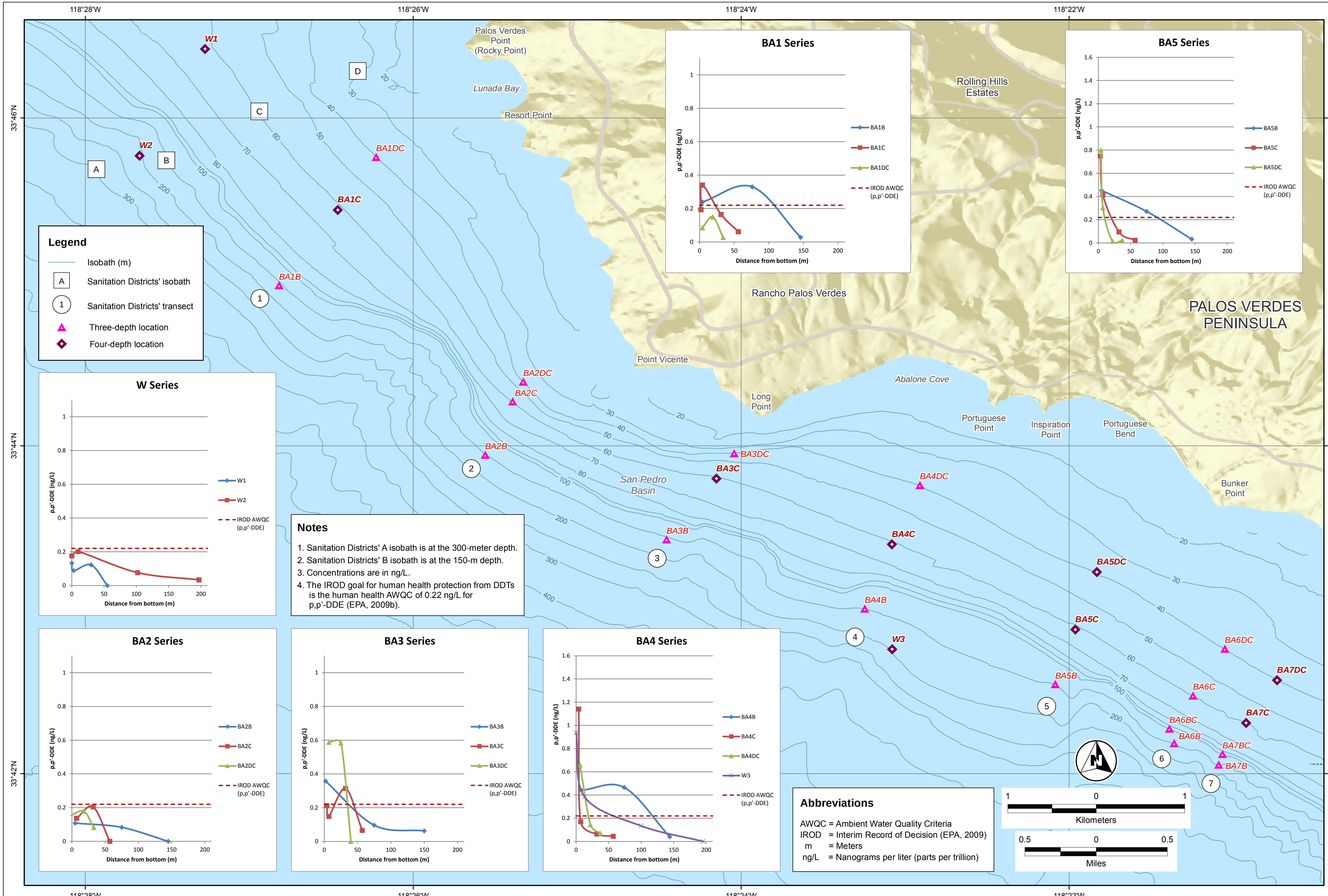
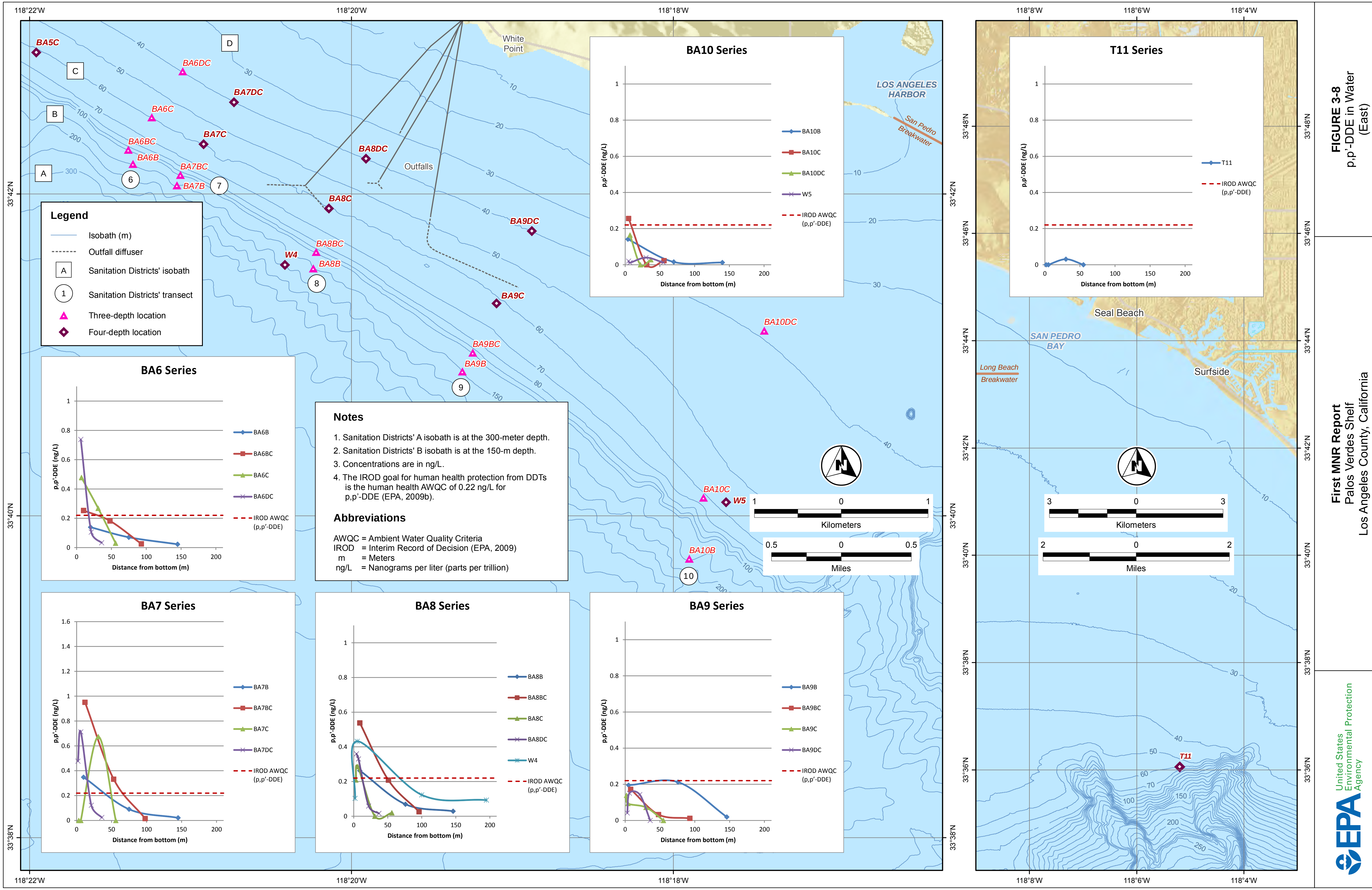


FIGURE 3-7
p,p'-DDE in Water (West)

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

United States Environmental Protection Agency



G:\ArcGIS\EPA\Palos_Verdes_Shelf\PROJECTS\MNR2017\Summary_ppDDE_East.mxd 4/17/2018 eanderson, Gilbane

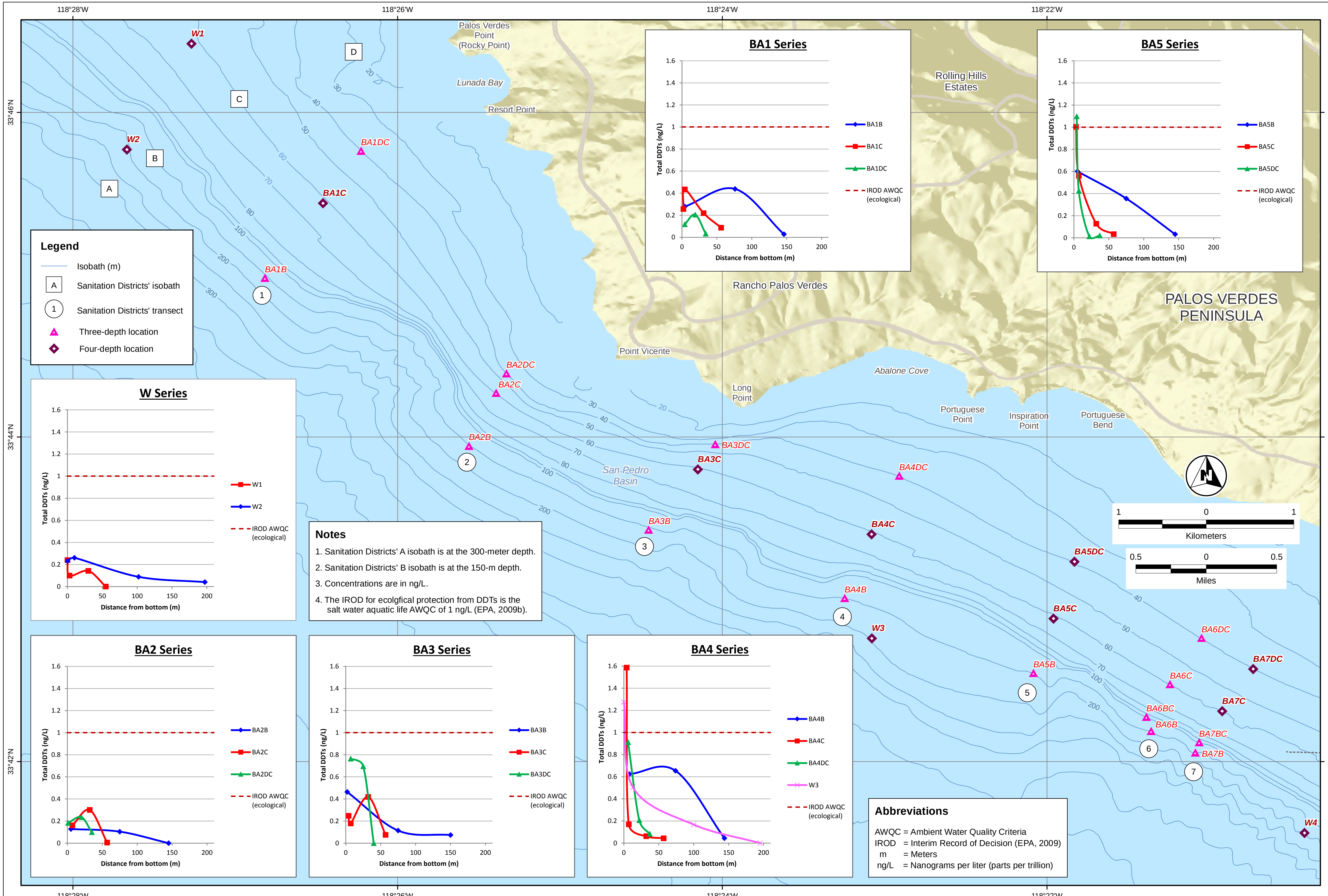


FIGURE 3-9
Total DDTs in Water (West)

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

United States Environmental Protection Agency
EPA

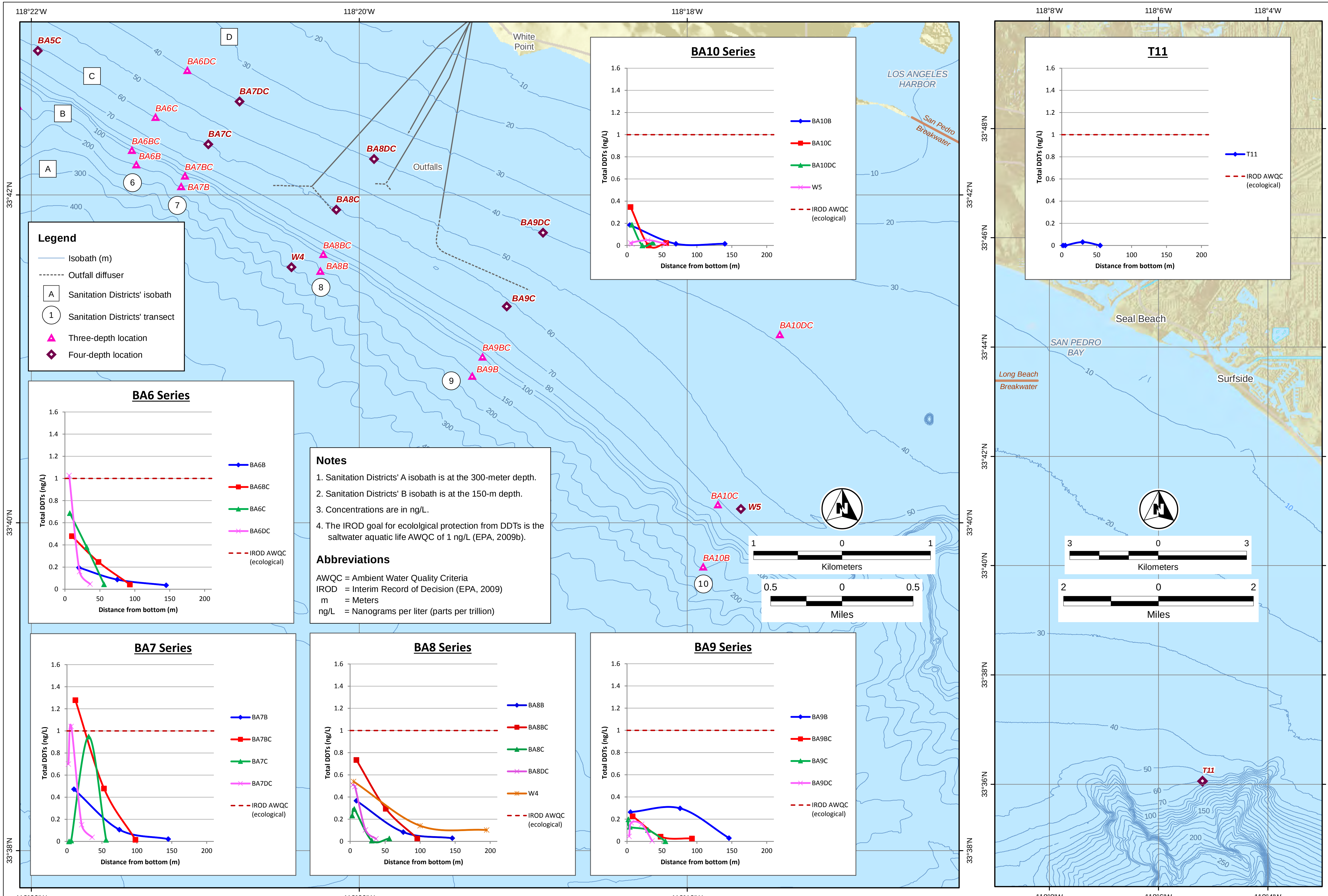


FIGURE 3-10
Total DDTs in Water
(East)

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

United States Environmental Protection Agency

G:\ArcGIS\EPA\Palos_Verdes_Shelf\PROJECTS\MNR2017\Summary_DDT_East.mxd 4/17/2018 eanderson, Gilbane

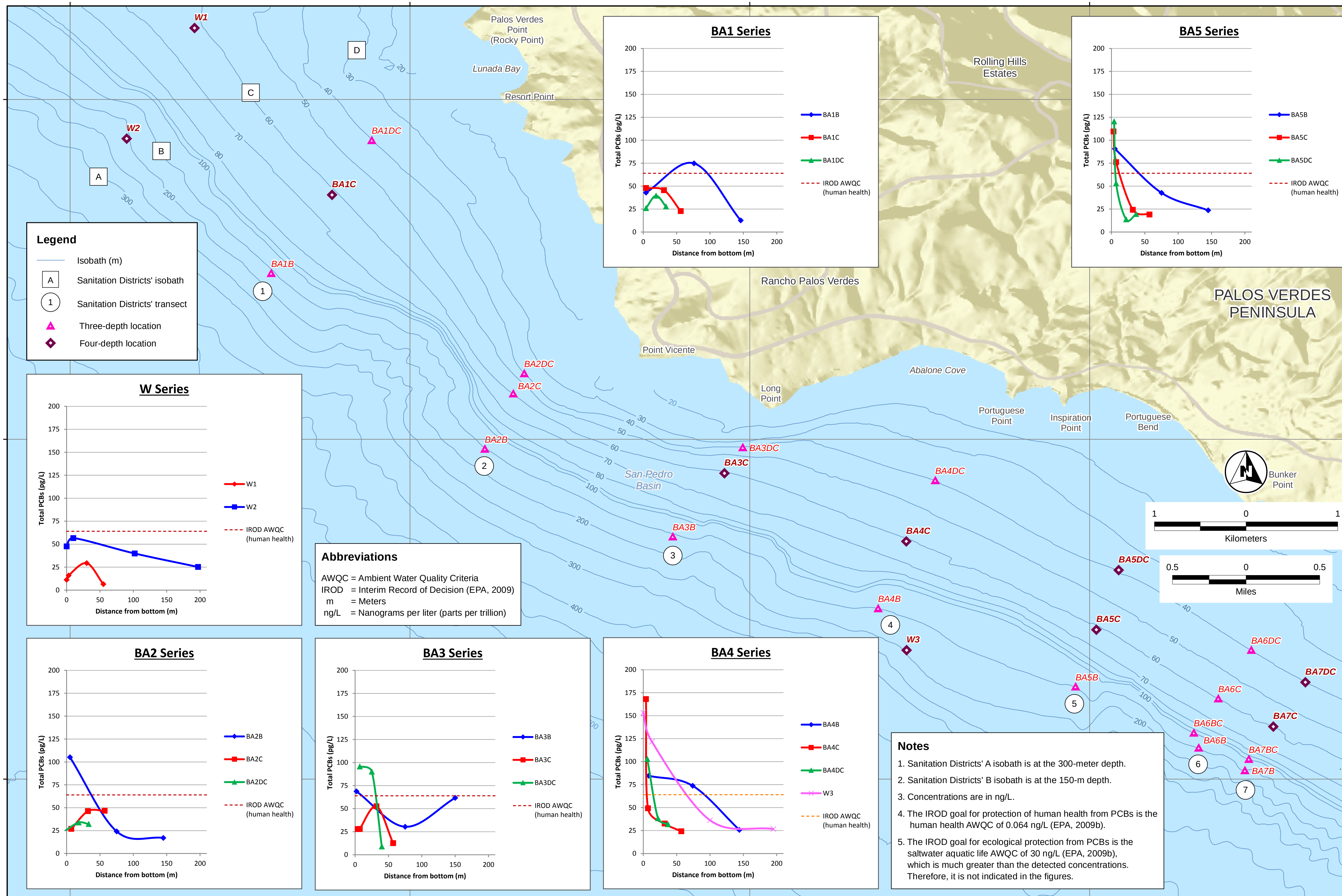


FIGURE 3-11
Total PCBs in Water (West)

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

EPA United States Environmental Protection Agency

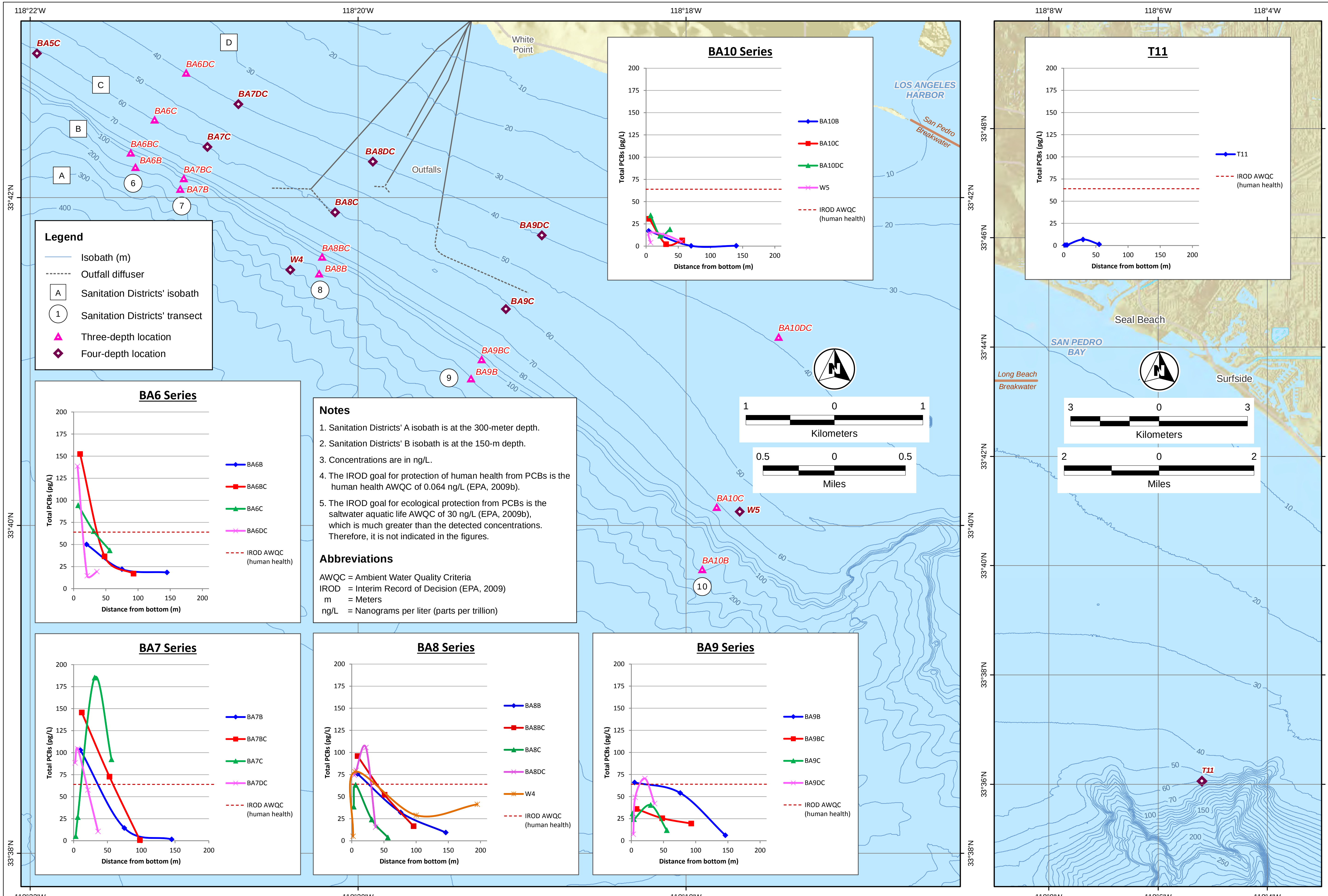


FIGURE 3-12
Total PCBs in Water (East)

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

United States Environmental Protection Agency

G:\ArcGIS\EPA\Palos_Verdes_Shelf\PROJECTS\MNR2017\Summary_PCB_East.mxd 4/17/2018 eanderson, Gilbane

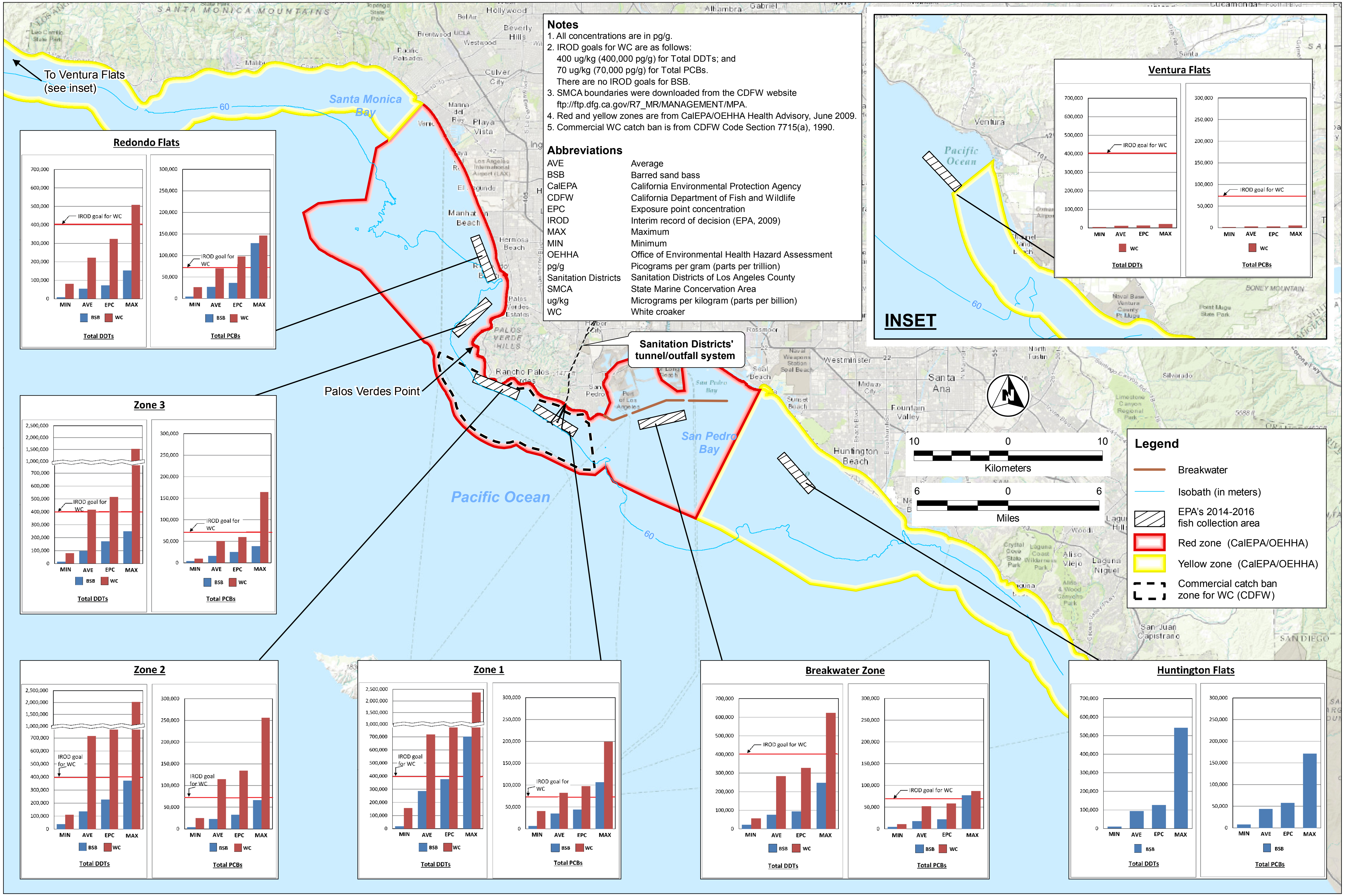
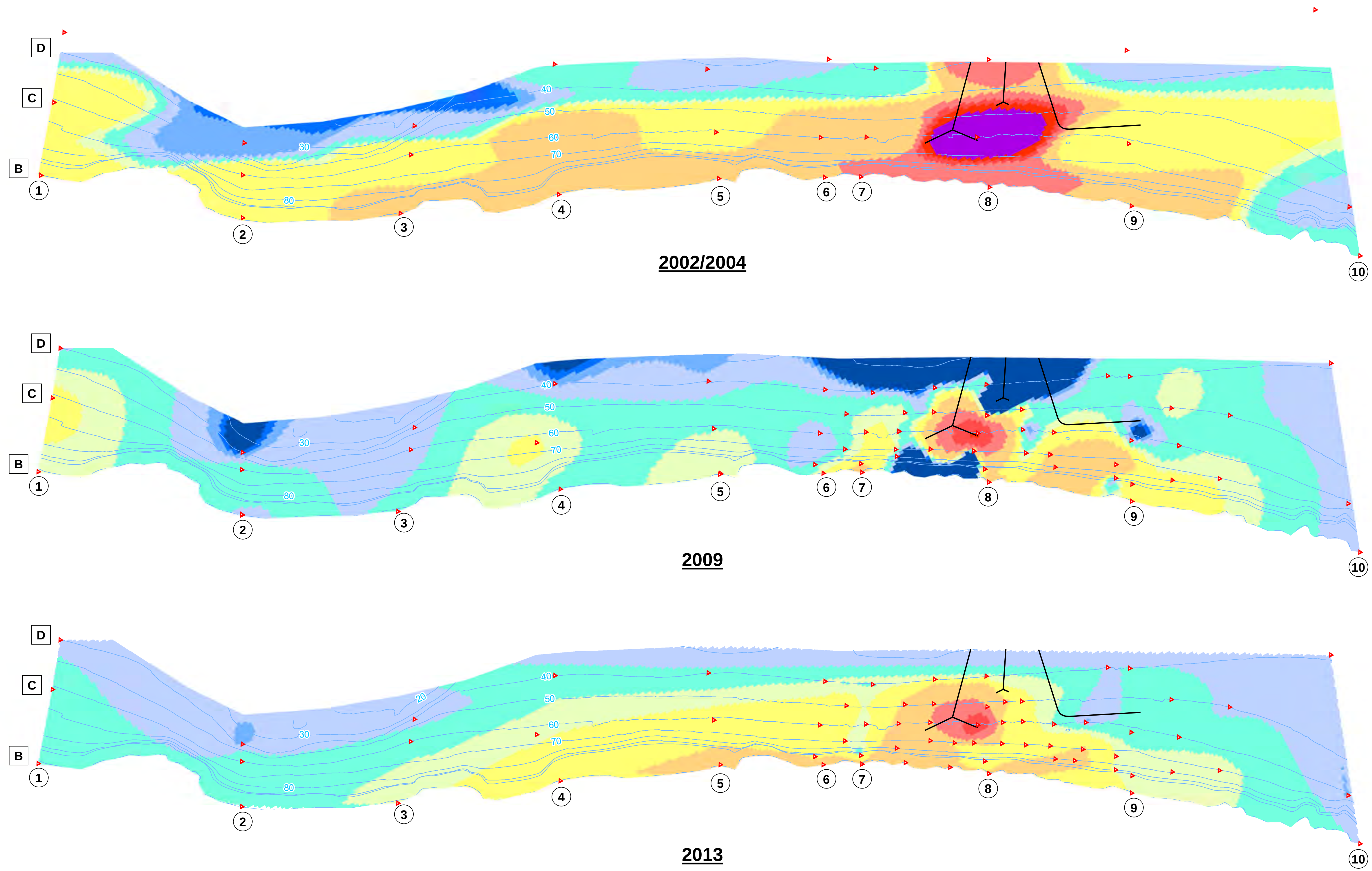


FIGURE 3-13
Summary of Fish Results

First MNR Report
Palos Verdes Shelf
Los Angeles County, California

United States Environmental Protection Agency



Legend

- Isobath (m)
- Outfall
- A Sanitation Districts' isobath
- 1 Sanitation Districts' transect
- Sediment core location

DDTs (mg/kg)

< 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

Notes

1. Data were not normalized for organic carbon.
2. The 2002/2004 image was based on the remedial investigation report (EPA, 2007b).

1.5 0 1.5
Kilometers

1 0 1
Miles

FIGURE 4-1
Time Trend –
Total DDTs in Sediment
(0-2-cm Bed-Depth Interval)

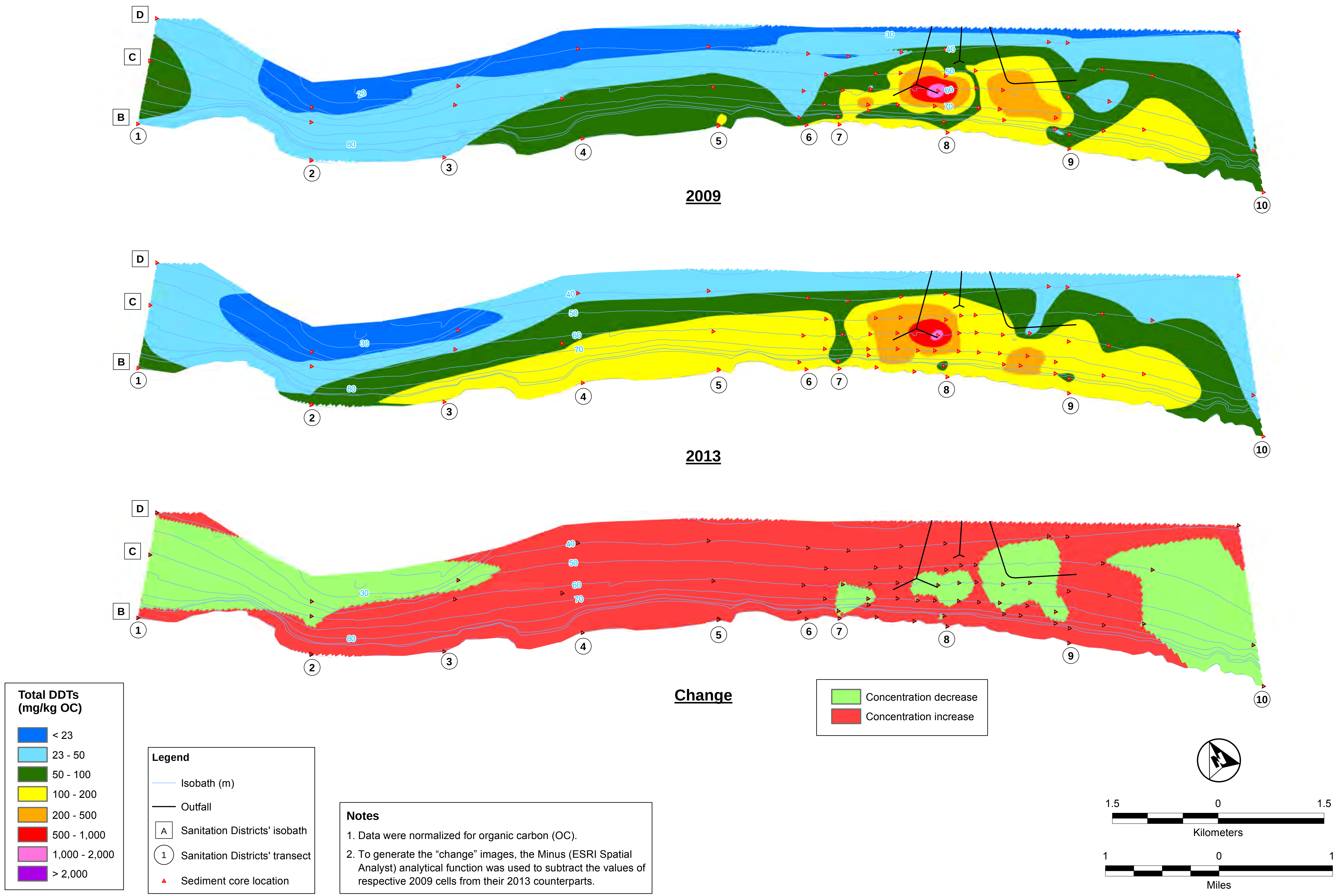
First MNR Report
Palos Verdes Shelf
Los Angeles County, California

EPA United States Environmental Protection Agency

G:\ArcGIS\EPA\Palos_Verdes_Shelf\PROJECTS\MNR2017\DDT_0_2cm.mxd 4/10/2018 eanderson, Gilbane

FIGURE 4-2
Time Trend –
Total DDTs in Sediment
(0-8-cm Bed-Depth Interval)

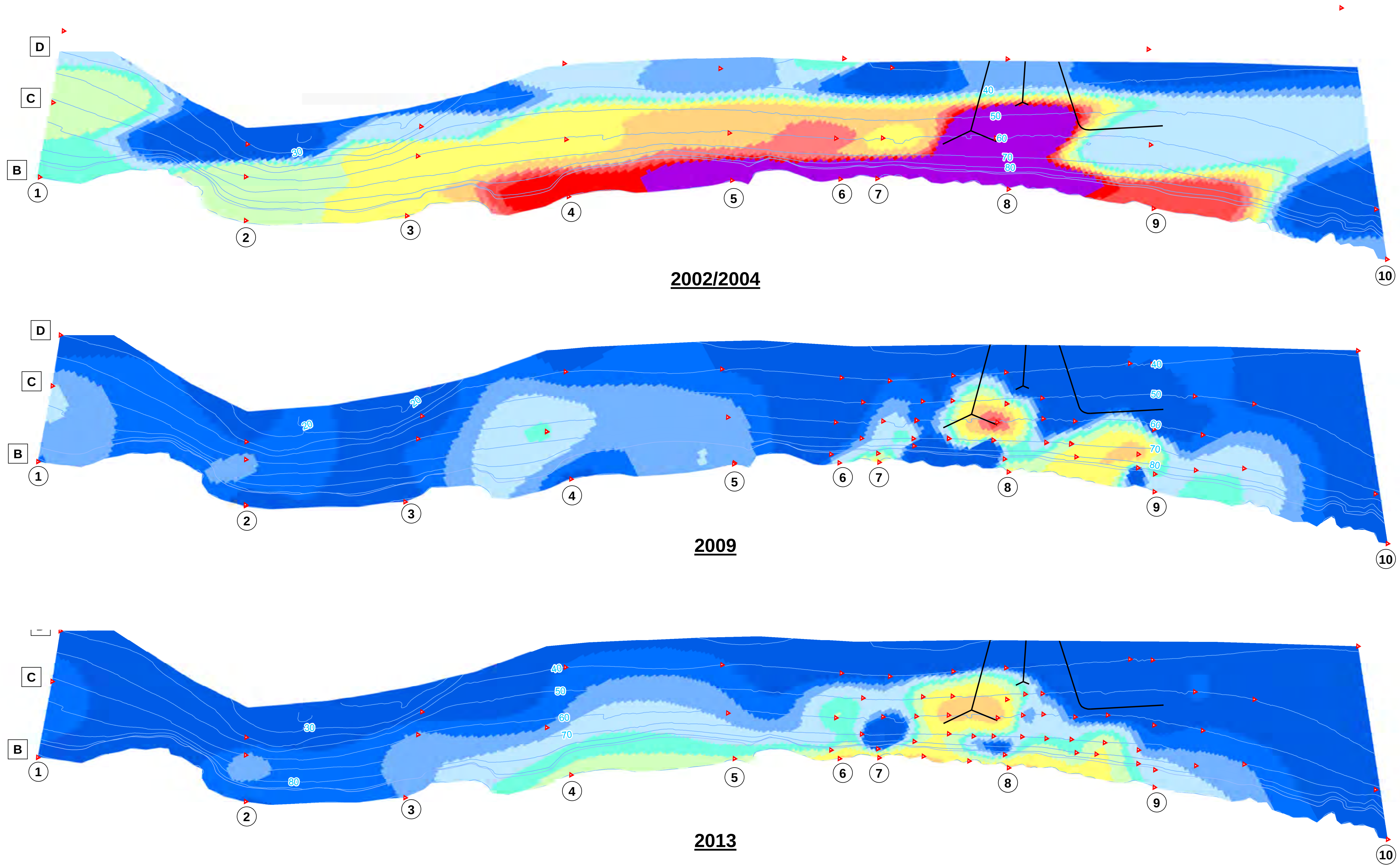
First MNR Report
Palos Verdes Shelf
Los Angeles County, California



Notes

1. Data were normalized for organic carbon (OC).
2. To generate the "change" images, the Minus (ESRI Spatial Analyst) analytical function was used to subtract the values of respective 2009 cells from their 2013 counterparts.

United States Environmental Protection Agency



Legend

- Isobath (m)
- Outfall
- A Sanitation Districts' isobath
- 1 Sanitation Districts' transect
- Sediment core location

Total PCBs (mg/kg)

< 0.05	0.3 - 0.5
0.05 - 0.075	0.5 - 0.75
0.075 - 0.1	0.75 - 1
0.1 - 0.15	1 - 1.25
0.15 - 0.2	1.25 - 1.5
0.2 - 0.3	1.5 - 2

Notes

1. Data were not normalized for organic carbon.
2. The 2002/2004 image was based on the remedial investigation report (EPA, 2007b).
3. The 2009 congener list (short list) was used for both the 2009 and 2013 data sets.

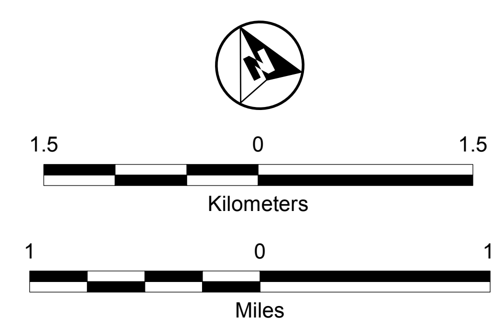


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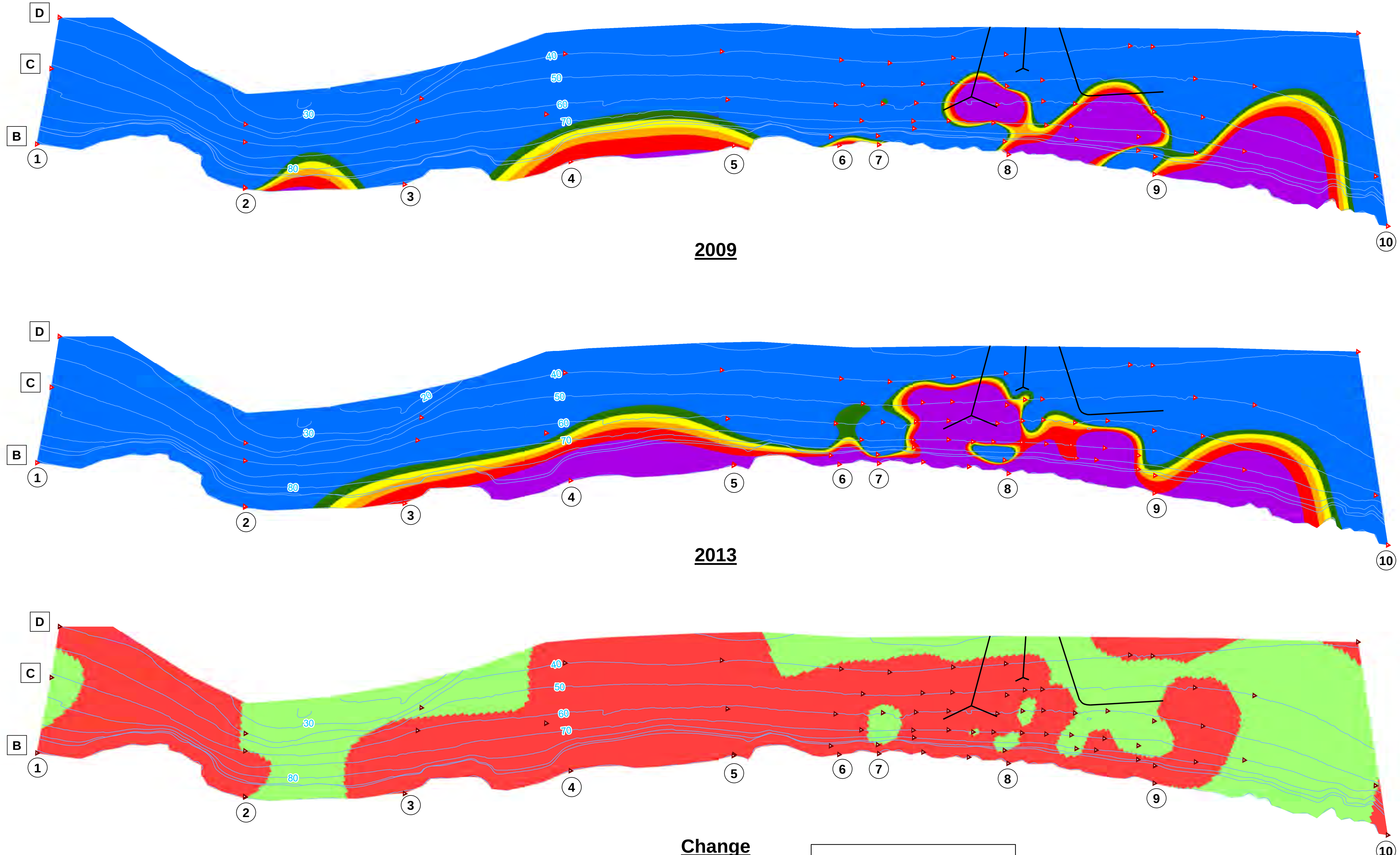
FIGURE 4-4
Time Trend –
Total PCBs in Sediment
(0-8-cm Bed-Depth Interval)



Total PCBs (mg/kg OC)

- < 7
- 7 - 8
- 8 - 9
- 9 - 10
- 10 - 12
- > 12

Legend

- Isobath (m)
- Outfall
- A Sanitation Districts' isobath
- 1 Sanitation Districts' transect
- Sediment core location

- Concentration Decrease
- Concentration Increase

Notes

1. Data were normalized for organic carbon.
2. The 2009 congener list (short list) was used for both the 2009 and 2013 data sets.
3. To generate the "change" images, the Minus (ESRI Spatial Analyst) analytical function was used to subtract the values of respective 2009 cells from their 2013 counterparts.

1.5 0 1.5
Kilometers

1 0 1
Miles

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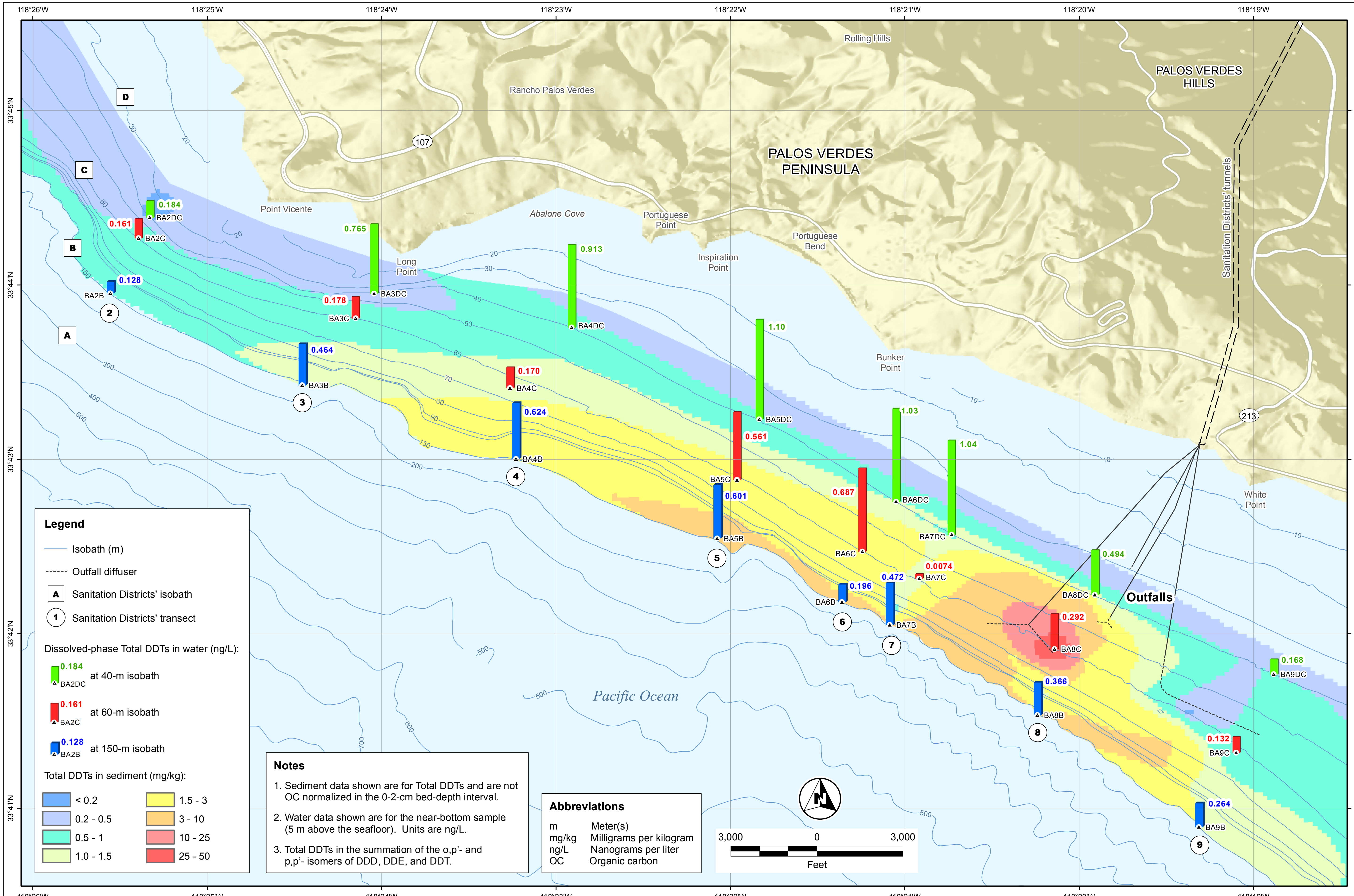

FIGURE 4-5
Total DDTs
in Sediment and Water

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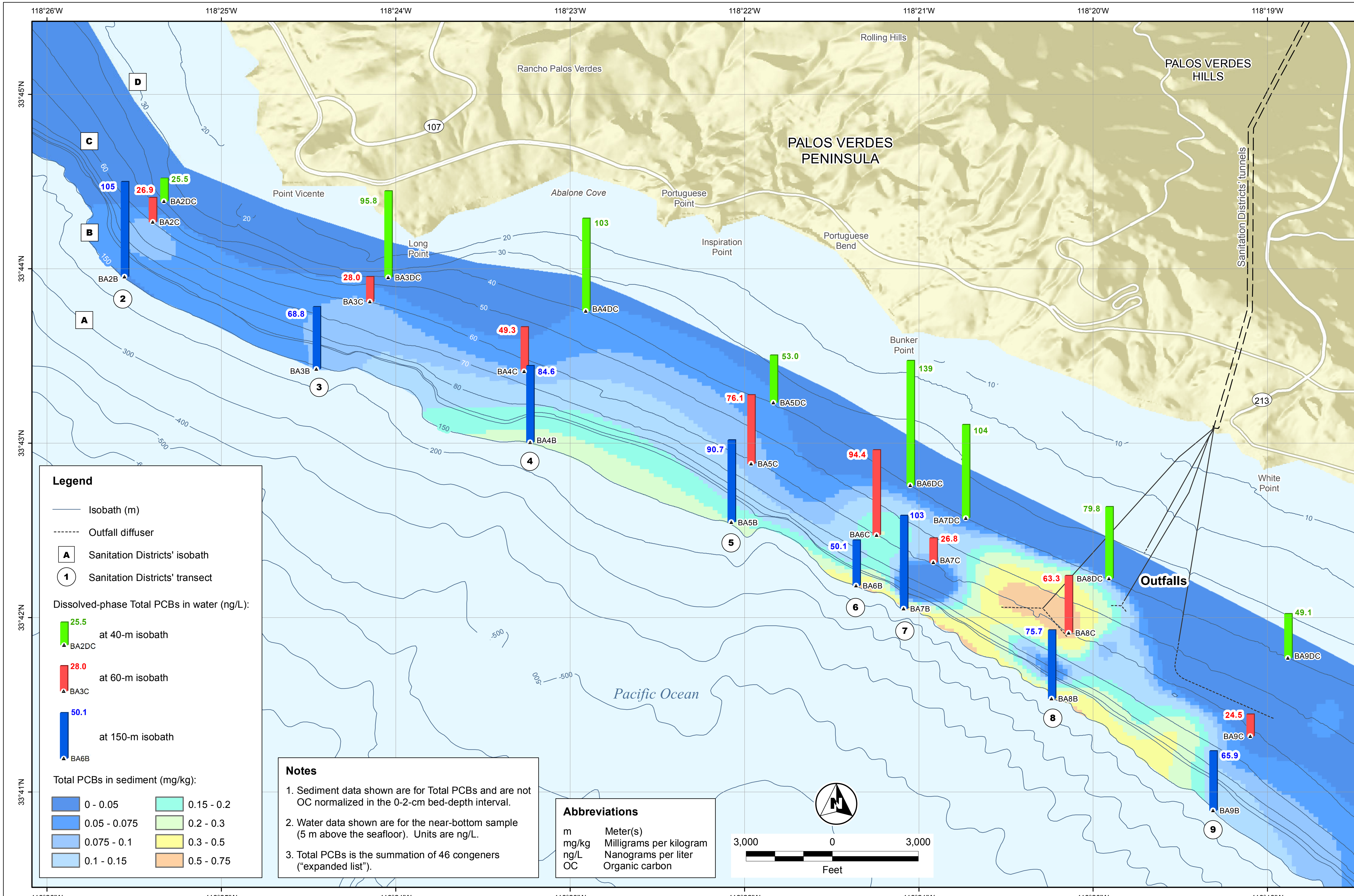

FIGURE 4-6
Total PCBs
in Sediment and Water

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