DEPARTMENT OF THE NAVY
BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
1455 FRAZEE RD, SUITE 900
SAN DIEGO, CA 92108-4310

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FEB 27 2009

Mr. Mark Ripperda (SFD-8-3)
U.S. Environmental Protection Agency, Region IX
75 Hawthorne Street
San Francisco, CA 94105-3901

Mr. Tom Lanphar
Department of Toxic Substances Control
700 Heinz Avenue, Bldg. F, Suite 200
Berkeley, CA 94710-2737

Mr. Erich Simon
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

Dear BCT Members:

Enclosure (1) is the Draft Final Parcel E-2 Remedial Investigation/ Feasibility Study (RI/FS) Report, Hunters Point Shipyard, San Francisco, California, February 27, 2009. Please provide comments **no later than March 31, 2009.**

If you should you have any concerns with this matter, please contact Ms. Lara Urizar at (619) 532-0960 or Mr. Keith Forman at (619) 532-0913.

Sincerely,

KEITH FORMAN
BRAC Environmental Coordinator
By direction of the Director

Enclosure: 1. Draft Final Parcel E-2 Remedial Investigation/Feasibility Study Report, February 27, 2009

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Copy to:

Ms. Amy Brownell (CD)
Department of Public Health
1390 Market Street, Suite 910
San Francisco, CA 94102

Ms. Dorinda Shipman (Hard Copy/CD)
555 Montgomery St., Suite 1300
San Francisco, CA 94111

Mr. Michael Jacobvitz (Hard Copy/CD)
5341 Old Redwood Highway, Suite 300
Petaluma, CA 94954

Ms. Karla Brasaemle (Hard Copy/CD)
90 New Montgomery Street, Suite 710
San Francisco, CA 94105

Ms. Elaine Warren (CD)
City Hall, Room 234
1 Dr. Carlton B. Goodlett Place
San Francisco, CA 94102-4682

Ms. Robert Carr (Hard Copy/CD)
75 Hawthorne Street (ORC-3)
San Francisco, CA 94105-3901

Mr. Gino Yekta (Hard Copy/CD)
1001 I Street
Sacramento, CA 95812-4025

Ms. Carol Allen (Hard Copy/CD)
939 Ellis Street
San Francisco, CA 94109

Ms. Diane Silva (3 Hard Copies/CD)
1220 Pacific Highway (Code EVR)
San Diego, CA 92132-5190

Dr. Daniel Stralka (Hard Copy/CD)
75 Hawthorne Street (SFD-8)
San Francisco, CA 94105-3901

Mr. Michael Sharpless (CD)
55 2nd Street, 24th Floor
San Francisco, CA 94104-2635

Mr. Henry Louie (CD)
1390 Market St., Suite 910
San Francisco, CA 94102

Dr. Michael McGowan (CD)
4634 Third Street
San Francisco, CA 94124

Mr. Leon Muhammad (Hard Copy/CD)
5048 Third Street
San Francisco, CA 94124

Ms. Laurie Lowman (Hard Copy/CD)
Building 1971 NWS
Yorktown, VA 23691-0260

Mr. Nixon Lam (CD)
P.O. Box 8097
San Francisco, CA 94128

Mr. Stan DeSouza (CD)
1680 Mission Street, First Floor
San Francisco, CA 94103-2414

Mr. Steve Hall (Hard Copy/CD)
1230 Columbia Street, Suite 1000
San Diego, CA 92101

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Mr. Jeff Austin (CD)
49 Stevenson Street, Suite 525
San Francisco, CA 94105

Mr. Thor Kaslofsky (CD)
1 South Van Ness Avenue
San Francisco, CA 94103

Ms. Arleen Navarret (CD)
1145 Market Street, Suite 401
San Francisco, CA 94102

Ms. Tamara Davidson (CD)
101 Grove Street, Room 217
San Francisco, CA 94102

Mr. Wayne Akiyama (CD)
4005 Port Chicago Highway
Concord, CA 94520-1120

Mr. Steve McAdam (CD)
50 California Street, Suite 2600
San Francisco, CA 94111

Pacific SW Regional Executive (CD)
U.S. Geological Survey
3020 State University Drive East
Modoc Hall, Suite 3005
Sacramento, CA 95819

Mr. Greg Santos (w/o encl)
1230 Columbia Street, Suite 750
San Diego, CA 92101

Anna E. Waden Library (Hard Copy)
5075 Third Street
San Francisco, CA 94124

Mr. Patrick Shea (Hard Copy)
100 Larkin Street
Gov. Information Ctr., 5th Floor
San Francisco, CA 94102

Dr. Jim Polisini (Hard Copy/CD)
9211 Oakdale Avenue
Chatsworth, CA 91311

Mr. Charlie Huang (Hard Copy/CD)
1700 K Street, Suite 250
Sacramento, CA 94244-2090

Mr. Robert Cotter (Hard Copy/CD)
P.O. Box 0915
San Francisco, CA 94143

Mr. David Belk (Hard Copy/CD)
50 Medical Center Way
San Francisco, CA 94143

Mr. Ryan Ahlersmeyer (CD)
1230 Columbia Street, Suite 540
San Diego, CA 92101

Mr. Stephen Bachman (CD)
845 Casa Grande Road
Petaluma, CA 94954

Public Summary: **Draft Final Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard, San Francisco, California, February 2009**

The Department of the Navy (Navy) has prepared a combined Remedial Investigation (RI)/Feasibility Study (FS) Report for the contiguous area consisting of the closed industrial landfill (referred to as the "Parcel E-2 Landfill") and the surrounding areas that contain isolated or non-contiguous pockets of buried solid waste at Parcel E-2, Hunters Point Shipyard in San Francisco, California. This RI/FS Report summarizes and evaluates the nature and extent of contamination using all available data, including information from removal actions that have removed potential contamination sources at Parcel E-2. The data were used to update risk assessments for humans and wildlife at Parcel E-2. The results from the nature and extent evaluation and risk assessments were used to identify remedial action objectives, and to develop remedial alternatives consistent with U.S. Environmental Protection Agency (EPA) RI/FS guidance for landfills.

Based on the nature and extent evaluation and the risk assessment results, the following media and affected areas pose potential threats to humans and wildlife and are analyzed in the FS: (1) solid waste and soil in the Parcel E-2 Landfill; (2) landfill gas; (3) soil and isolated solid waste in the surrounding areas; (4) groundwater in the A-aquifer and B-aquifer; (5) surface water runoff; and (6) shoreline sediment. Consistent with EPA RI/FS guidance and the National Oil and Hazardous Substances Pollution Contingency Plan, the Navy evaluated a focused set of remedial alternatives for Parcel E-2 that included (1) no action; (2) excavate and dispose of solid waste, soil, and sediment; (3) contain solid waste, soil, and sediment with hot spot removal; and (4) contain solid waste, soil, sediment, and groundwater with hot spot removal. Alternatives 2, 3, and 4 also include monitoring of contaminated media (such as groundwater) and institutional controls that would be implemented across the entire parcel to prevent exposure to contaminated soil and groundwater.

Information Repositories: A complete copy of the "Draft Final Remedial Investigation/Feasibility Study Report for Parcel E-2," dated February 2009, is available to community members at:

San Francisco Main Library
100 Larkin Street
Government Information Center, 5th Floor
San Francisco, CA 94102
Phone: (415) 557-4500

Anna E. Waden Bayview Library
5075 Third Street
San Francisco, CA 94124
Phone: (415) 715-4100

The report is also available to community members on request to the Department of the Navy. For more information about environmental investigation and cleanup at Hunters Point Shipyard, contact Keith Forman, BRAC Environmental Coordinator for the Navy, at:

Keith Forman
Department of the Navy
Base Realignment and Closure, Program Management Office West
1455 Frazee Road, Suite 900
San Diego, CA 92108-4310
Phone: (415) 308-1458
Fax: (619) 532-0995
E-mail: keith.s.forman@navy.mil

Draft Final

Remedial Investigation/Feasibility Study Report for Parcel E-2

Hunters Point Shipyard
San Francisco, California

February 2009

Prepared for:
Base Realignment and Closure
Program Management Office West
San Diego, California 92108

Prepared by:
Engineering/Remediation Resources Group, Inc.
115 Sansome Street, Suite 200
San Francisco, California 94104

and

Shaw Environmental, Inc.
4005 Port Chicago Highway
Concord, California 94520

Prepared under:
Naval Facilities Engineering Command Southwest
Contract Number N68711-05-C-6011

DCN: ERRG-6011-0000-0002

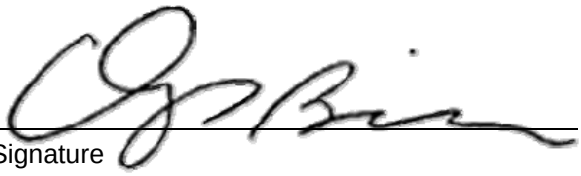
Draft Final

Remedial Investigation/Feasibility Study Report for Parcel E-2 Hunters Point Shipyard, San Francisco, California

February 2009

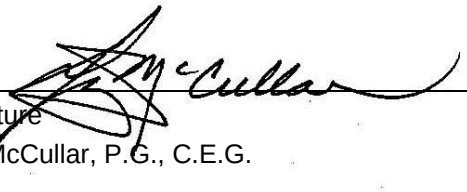
Submitted by:

Engineering/Remediation Resources Group, Inc. and Shaw Environmental, Inc.



Signature
Doug Bielskis, P.E.

February 27, 2009
Date
ERRG Project Manager



Signature
Dan McCullar, P.G., C.E.G.

February 27, 2009
Date
Shaw Project Manager

Table of Contents

Table of Contents *(continued)*

Table of Contents *(continued)*

List of Figures

List of Figures *(continued)*

List of Figures *(continued)*

List of Figures *(continued)*

List of Figures *(continued)*

List of Figures *(continued)*

List of Tables

List of Tables *(continued)*

List of Tables *(continued)*

List of Appendices

Acronyms and Abbreviations

§	Section
µg/L	micrograms per liter
AFA	AFA Construction Group
ARAR	applicable or relevant and appropriate requirement
ARIC	area requiring institutional controls
ATSDR	Agency for Toxic Substances and Disease Registry
ATT	Aqua Terra Technologies
BAAQMD	Bay Area Air Quality Management District
Basin Plan	Comprehensive Water Quality Control Plan for the San Francisco Bay Basin
Bay	San Francisco Bay
BCDC	San Francisco Bay Conservation and Development Commission
BCT	Base Realignment and Closure Cleanup Team
BERA	baseline ecological risk assessment
BGMP	Basewide Groundwater Monitoring Program
bgs	below ground surface
BHC	benzene hexachloride
BMPs	best management practices
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene, and xylenes
Cal/EPA	California Environmental Protection Agency
CCR	California Code of Regulations
CDM	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIWMB	California Integrated Waste Management Board
cm/sec	centimeters per second
COCs	chemicals of concern
COECs	chemicals of ecological concern
COPCs	chemicals of potential concern
COPECs	chemicals of potential ecological concern
CPT	cone penetrometer test

CSC	California species of special concern
CTR	California Toxics Rule
DCA	dichloroethane
DCB	dichlorobenzene
DCE	dichloroethene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DHS	Department of Health Services
DNAPL	dense nonaqueous-phase liquid
DoD	U.S. Department of Defense
DQO	data quality objective
DTSC	Department of Toxic Substance Control
EE/CA	engineering evaluation/cost analysis
EEC	Eagle Environmental Construction
ELCRs	excess lifetime cancer risks
EMCON	EMCON Associates
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
ER-M	effects range-median
ERRG	Engineering/Remediation Resources Group, Inc.
ESAP	environmental sampling and analysis plan
ESL	environmental screening level
FFA	Federal Facilities Agreement
FS	Feasibility Study
FSP	field sampling plan
GAC	granular activated carbon
GCL	geosynthetic clay liner
GDGI	groundwater data gaps investigation
GES	groundwater extraction system
GMP	gas monitoring probe
gpd	gallons per day

GRA	general response action
GRI	Geosynthetic Research Institute
HELP-3	Hydrogeologic Evaluation of Landfill Performance, Version 3
HDPE	high-density polyethylene
HGAL	Hunters Point groundwater ambient levels
HHRA	human health risk assessment
HI	hazard index
HLA	Harding Lawson Associates
HPALs	Hunters Point ambient levels
HPS	Hunters Point Shipyard
HQs	hazard quotients
HRA	Historical Radiological Assessment
IAS	Initial Assessment Study
IDW	investigation-derived waste
IPCC	Intergovernmental Panel on Climate Change
IR	Installation Restoration
IT	International Technology Corporation
ITSI	Innovative Technical Solutions, Inc
Kleinfelder	Kleinfelder, Inc.
LEL	lower explosive limit
LFR	Levine-Fricke-Recon
LNAPL	light non-aqueous phase liquid
LRLs	laboratory reporting limits
LUC	land use control
MACTEC	MACTEC Engineering and Consulting
MARRS	MARRS Services, Inc.
MCLs	maximum contaminant levels
MDLs	method detection limits
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MOA	Memorandum of Agreement
MPE	maximum probable earthquake

MPPEH	material potential presenting an explosive hazard
msl	mean sea level
NACIP	Navy Assessment and Control of Installation Pollutants
NAVFAC	Naval Facilities Engineering Command
NAVSEA	Naval Sea Systems Command
Navy	Department of the Navy
NAWQC	National Ambient Water Quality Criteria
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDGIs	nonstandard data gaps investigations
NEESA	Naval Energy and Environmental Support Activity
NMOC	nonmethane organic compound
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRDL	Naval Radiological Defense Laboratory
NTCRA	non-time-critical removal action
O&M	operation and maintenance
PAHs	polycyclic aromatic hydrocarbons
PAMP	perimeter air monitoring program
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
pCi/L	picoCuries per liter
PeCDF	pentachlorodibenzofuran
PMO	Program Management Office
ppm	parts per million
ppmv	parts per million by volume
PQL	practical quantitation limit
PRB	permeable reactive barrier
PRC	PRC Environmental Management
PRG	preliminary remediation goal
PSC	protective soil concentration
PV	present value
PVC	polyvinyl chloride
QAPP	quality assurance project plan
QCSR	quality control summary report

R&D	research and development
RAOs	remedial action objectives
RASO	Radiological Affairs Support Office
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RI	Remedial Investigation
RIEC	remedial investigation evaluation criteria
RME	reasonable maximum exposure
RMP	Risk Management Plan
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board
SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act
SCRS	surface confirmation radiation survey
SDGI	standard data gap investigation
SFDA	San Francisco District Attorney
SFRA	San Francisco Redevelopment Agency
Shaw	Shaw Environmental, Inc.
SLERA	screening-level ecological risk assessment
SPT	standard penetration test
SSF	site specific factors
SVOCs	semivolatile organic compounds
SWAQAT	Solid Waste Air Quality Assessment Test
SWDMP	Stormwater Discharge Management Plan
SWRCB	State Water Resources Control Board
TCA	trichloroethane
TCE	trichloroethene
TCRA	time-critical removal action
TDS	total dissolved solids
TEQ	toxicity equivalency quotient
TIZ	tidal influenced zone
TMZ	tidal mixing zone
TOG	total oil and grease
TPH	total petroleum hydrocarbons

TPH-d	TPH as diesel
TPH-g	TPH as gasoline
TPH-mo	TPH as motor oil
Triple A	Triple A Machine Shop, Inc.
TRVs	toxicity reference values
TtECI	Tetra Tech EC, Inc.
TtEMI	Tetra Tech EM Inc.
TtFW	Tetra Tech FW, Inc.
U&A	Uribe and Associates, Inc.
UCL	upper confidence limit
UCSF	University of California, San Francisco
USACE	U.S. Army Corps of Engineers
UXO	unexploded ordnance
VOCs	volatile organic compounds
WBZ	water-bearing zone
WMMP	wetlands mitigation and monitoring plan
WQOs	water quality objectives

Executive Summary

The Department of the Navy (Navy) has prepared this combined Remedial Investigation (RI)/Feasibility Study (FS) Report for the area consisting of the closed industrial landfill (hereafter identified as the "Parcel E-2 Landfill") and the surrounding areas that contain isolated or noncontiguous pockets of buried solid waste within Parcel E-2 at Hunters Point Shipyard (HPS) in San Francisco, California. This RI/FS Report is part of ongoing efforts by the Navy to address contamination at Parcel E-2 in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Title 42 United States Code [USC] Sections [§§] 9601-9675).

Because past shipyard operations left hazardous materials on site, HPS property was placed on the National Priorities List in 1989 as a Superfund site pursuant to CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986. In 1991, HPS was designated for closure pursuant to the Defense Base Closure and Realignment Act of 1990. Closure activities at HPS involve conducting environmental remediation and making the property available for nondefense use. As a management tool to accelerate site investigation, cleanup, and reuse, HPS was divided into parcels. Sites within each parcel are evaluated concurrently. In September 2004, the Navy divided Parcel E into two parcels (Parcels E and E-2) to facilitate closure of the Parcel E-2 Landfill and its adjacent areas.

This RI/FS Report summarizes and evaluates the nature and extent of contamination using all available data, including information from removal actions that have removed potential contamination sources at Parcel E-2. The data were used to update risk assessments for humans and wildlife at Parcel E-2. Results from the nature and extent evaluation and risk assessments were used to identify remedial action objectives (RAOs), and to develop remedial alternatives consistent with U.S. Environmental Protection Agency (EPA) RI/FS guidance for landfills (EPA, 1991a). Each remedial alternative was evaluated in accordance with criteria established in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Title 40 Code of Federal Regulations [CFR] Part 300). This RI/FS Report addresses CERCLA hazardous substances except for radionuclides. Potential radiological contamination will be addressed in a radiological addendum to the RI/FS Report. Both chemical and radiological contaminants will then be addressed together in the proposed plan and the Record of Decision (ROD).

ES.1. SITE HISTORY AND PLANNED REUSE

Parcel E-2 consists of 47.4 acres of shoreline and lowland coast along the southwestern portion of HPS, and contains four distinct areas, which were designated to streamline the information presented in this RI/FS Report (Figure ES-1):

1. The "Landfill Area," which comprises the entire Parcel E-2 Landfill and its immediate perimeter
2. The "Panhandle Area," located west and southwest of the Landfill Area
3. The "East Adjacent Area," located to the east of the Landfill Area
4. The "Shoreline Area" located at the interface with San Francisco Bay

Based on the City and County of San Francisco's Redevelopment Plan for HPS, Parcel E-2 is designated for open space reuse except for a small area in the Landfill Area and a portion of the East Adjacent Area, which is designated for industrial and research and development (R&D) reuse (San Francisco Redevelopment Agency, 1997). When the parcel is transferred to the city, restrictive covenants will be incorporated to prohibit certain construction activities within Parcel E-2. These restrictions will affect the area of industrial and R&D uses, but will be consistent with the intentions of the Redevelopment Plan.

ES.1.1. Operational History

Parcel E-2 is part of an area created in the 1940s, 1950s, and 1960s by filling in the bay margin with various material, including soil, crushed bedrock, dredged sediments, and debris. The overall composition of the fill material, on which the Parcel E-2 Landfill was created, is primarily sand and clay with intermixed construction debris (Tetra Tech EM Inc. [TtEMI], 2004f). Almost all of the land at HPS was created by filling activities conducted between the early 1940s and the late 1960s.

Between 1958 and 1974, the Navy created the Parcel E-2 Landfill by placing various shipyard wastes, including construction debris, municipal-type solid waste, and industrial waste (including sandblast waste, paint sludge, solvents, and waste oils) (Naval Energy and Environmental Support Activity [NEESA], 1984). As a result, the landfill has a heterogeneous composition and includes solid waste intermixed with soil fill. The physical extent of solid waste covers approximately 22 acres (TtEMI, 2004f). Shortly after landfill operations ceased in 1974, the Navy implemented several preliminary landfill closure measures, including placing a minimum of 2 feet of compacted, imported fill on top of the landfill.

Between 1976 and 1986, industrial operations conducted by a lessee of the property (Triple A Machine Shop, Inc.) allegedly resulted in the disposal of industrial debris, sandblast waste, oily industrial sand, and asphalt over an area of approximately 5 acres along the shoreline in Parcel E-2 and in a portion of the Landfill Area. The lessee also allegedly stored unlabeled, deteriorating, uncovered drums with their contents exposed to the elements in the southeast portion of Parcel E-2 (San Francisco District Attorney, 1986).

ES.1.2. Investigation Activities

Environmental investigations performed from 1984 to 1996 were evaluated in RI and FS reports for Parcel E, which encompassed the area later subdivided as Parcel E-2. During preparation of these reports, the Navy and regulatory agencies decided that additional data gaps investigations were needed to better define the nature and extent of chemicals in soil and groundwater at Parcel E-2, and to better evaluate site

conditions in and around the Parcel E-2 Landfill. Previous environmental investigations at Parcel E-2 are listed below.

ENVIRONMENTAL INVESTIGATION ACTIVITIES AT PARCEL E-2

- 1984 Initial Assessment Study
- 1987 Confirmation Study/Verification Step, Area Study for Asbestos-Containing Material and Organic and Inorganic Soil Contamination
- 1986-1988 Triple A Investigation, Remedial Action Order and RI/FS Scoping Document
- 1988-1989 Solid Waste Air Quality Assessment Test
- 1988-1992 Operable Unit I Remedial Investigation
- 1991-1992 Intertidal Sediment Study
- 1991, 1993 Radiological Investigation (Phases I and II)
- 1994-1996 Ecological Risk Assessment (Phases 1A and 1B)
- 1995-1998 Parcel E Remedial Investigation and Feasibility Study

ES.1.3. Interim Removal Actions

The Navy has performed several interim removal actions at Parcel E-2 to minimize potential exposure of hazardous substances and to expedite the cleanup process. Removal actions conducted to date are listed below.

REMOVAL ACTIONS AT PARCEL E-2 (FIGURE ES-1)

- Groundwater Extraction System, 1997-1998: a groundwater containment and extraction system was installed at the southeast portion of Parcel E-2 to reduce the potential for release of landfill constituents into San Francisco Bay.
- Landfill Cap Construction, 2000-2001: a multilayer interim cap was constructed on a portion of the Parcel E-2 Landfill to prevent oxygen intrusion and extinguish smoldering subsurface areas following a brush fire.
- Landfill Gas Removal Action, 2002-2003: a landfill gas control and monitoring system was installed along the northern Parcel E-2 boundary to control gas migration from the landfill.
- Metal Slag Area Removal Action, 2005-2007: 8,200 cubic yards of contaminated soil and sediment, including 119 cubic yards of radiologically impacted soil and debris, was excavated and disposed of off site from this area in the southwest portion of Parcel E-2.
- Polychlorinated Biphenyl Hot Spot Area Removal Action, 2005–2007: 44,500 cubic yards of contaminated soil, including 611 cubic yards of radiologically impacted soil and debris, was excavated from this area and disposed of off site in the southeast portion of Parcel E-2.

ES.1.4. Ongoing Monitoring Programs

The Navy has implemented several environmental monitoring programs to satisfy regulatory requirements for Parcel E-2 until a final remedy is selected. The ongoing monitoring programs at Parcel E-2 are summarized below.

ONGOING MONITORING PROGRAMS IMPLEMENTED AT PARCEL E-2

- 2003-Present Stormwater Discharge Management Program
- 2003-Present Landfill Cover Inspection and Maintenance Program

ES.2. NATURE AND EXTENT OF CONTAMINATION

The nature and extent evaluation was performed for the following potentially contaminated media: (1) solid waste and soil in the Landfill Area; (2) landfill gas; (3) soil and isolated solid waste in the adjacent areas (Panhandle, East Adjacent, and Shoreline Areas); (4) groundwater; (5) surface water; and (6) shoreline sediment. Data were initially evaluated to identify chemicals whose presence may be attributed to the Navy's past site operations. The evaluation was then focused by comparing the site data against remedial investigation evaluation criteria (RIEC). The RIEC were selected based on regulatory criteria and are adequately conservative to show the extent of chemicals that may pose a risk to human health or the environment.

ES.2.1. Solid Waste and Soil in the Landfill Area

The contiguous solid waste in the Landfill Area is composed primarily of municipal-type waste and construction debris. The waste was observed in 28 soil borings, 18 monitoring wells, and 25 test pits extended within the Landfill Area. The solid waste includes wood, paper, plastic, metal, glass, asphalt, concrete, and bricks that are mixed with sand, clay, and gravel fill. Construction debris (such as asphalt, concrete, and brick) is typically inert and is not expected to generate leachate that would create potential risks to human health or the environment.

In addition to municipal-type waste and construction debris, historic information indicates that industrial wastes were also disposed of in or around the Landfill Area, including sandblast waste, radioluminescent devices, asbestos-containing debris, paint sludge, solvents, and waste oils (NEESA, 1984; Naval Sea Systems Command, 2004). The presence of some of these industrial wastes was confirmed during cleanup activities within the Polychlorinated Biphenyl (PCB) Hot Spot Area, which extended into a small portion the Landfill Area (Navy, 2005b through 2005f; Tetra Tech EC, Inc. [TtECI], 2007a). The characterization data suggest that the quantity of industrial waste within the Landfill Area is less than the quantity of municipal-type waste and construction debris.

The areal extent of solid waste covers approximately 22 acres, and the estimated volume of the solid waste is 473,000 cubic yards. Waste across the Landfill Area varies from less than 10 feet thick to greater than 25 feet thick (with an average of about 13 feet thick). In most areas of the Parcel E-2 Landfill, waste is in direct contact with groundwater.

The soil data set within the Landfill Area was derived from 333 soil samples collected from the intermittent soil fill mixed within the solid waste. Metals, semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), PCBs, pesticides, and petroleum hydrocarbons were detected at concentrations exceeding the RIEC in soil samples collected at the Landfill Area. Soil characterization data within the Landfill Area are used to assess the general extent of RIEC exceedances relative to the landfill waste volume. This assessment provides a basis for determining whether lesser quantities of hazardous wastes are present in the landfill as compared with municipal wastes, which is one evaluation factor outlined in EPA presumptive remedy guidance (provided in Appendix H of this report). Nearly all of the chemicals detected in Landfill Area soil at concentrations above RIECs were of a limited extent relative to the overall waste volume. These results indicate that lesser quantities of potentially hazardous industrial wastes are present in the landfill as compared with municipal-type waste and construction debris.

The nature and extent of solid waste and chemicals in soil within the Landfill Area is adequately characterized to evaluate a focused set of remedial alternatives in the FS. This determination is based in large part on EPA presumptive remedy guidance for CERCLA landfills (EPA, 1993a, 1993b, 1994, and 1996). Consistent with EPA guidance, characterization of the solid waste is not necessary or appropriate for selecting a response action for the Landfill Area.

ES.2.2. Landfill Gas

Landfill gas characterization, consisted of installation of temporary soil gas borings and 21 permanent gas monitoring probes (GMPs). It was determined that methane was present at concentrations exceeding 25 percent of the lower explosive limit (LEL), equivalent to 1.25 percent methane by volume, north of the Parcel E-2 Landfill (including property owned by the University of California San Francisco [UCSF]). Methane was not detected at concentrations exceeding 25 percent of the LEL in locations along Crisp Avenue (approximately 200 feet north of the landfill) or to the east, south, and west of the landfill. Nonmethane organic compounds (NMOCs) were detected in both the temporary soil gas borings and the permanent GMPs, with the highest concentrations immediately north of the landfill.

Upon completion of the landfill gas characterization, the Navy conducted a removal action to (1) remove landfill gas and reduce subsurface methane concentrations at the UCSF compound to below the LEL (5 percent methane by volume in air); and (2) control future migration of landfill gas to off-site areas. The removal action involved installation and operation of a gas control, extraction, and treatment system. Monitoring is performed on a monthly basis and includes notification and response procedures if hazardous concentrations of landfill gas (either methane or NMOCs) are detected beyond the fence line of

the landfill and beneath the UCSF compound. Data collected as part of the landfill gas characterization study, the removal action, and ongoing landfill gas monitoring have adequately defined the nature and extent of landfill gas at Parcel E-2.

ES.2.3. Soil and Isolated Solid Waste in the Panhandle and East Adjacent Areas

The nature and extent of solid waste in the Panhandle and East Adjacent Areas are distinct from the solid waste defined in the Landfill Area. Specifically, fill material in the Panhandle and East Adjacent Areas consists primarily of soil and rock with isolated solid waste locations that are not contiguous with solid waste in the Landfill Area. Solid waste within the Panhandle and East Adjacent Areas consists of a heterogeneous distribution of construction debris (primarily concrete, brick, wood, and asphalt) and isolated locations of industrial wastes (such as, sandblast waste, metal slag, radioluminescent devices, and oily waste). Industrial wastes have been encountered in the two Parcel E-2 areas where removal actions were recently completed. Industrial wastes encountered within the Metal Slag Area (in the Panhandle Area) and the PCB Hot Spot Area (in the East Adjacent Area) were removed and disposed of off site; however, chemical concentrations in soil remain at both areas and warrant further analysis in the FS portion of this report.

The soil data set was derived from 754 soil samples (113 soil borings, 113 excavation grids within the PCB Hot Spot Area and Metal Slag Area, and 14 test pits) collected within the Panhandle and East Adjacent Areas. Metals, SVOCs, VOCs, pesticides, PCBs, dioxins and furans, and petroleum hydrocarbons were detected at concentrations exceeding RIECs in soil samples collected in the Panhandle and East Adjacent Areas. Soil contamination is more widely distributed in the Panhandle Area and the shallow zones (0 to 10 feet below ground surface [bgs]) of the East Adjacent Area. Soil contamination is less extensive within East Adjacent Area soils at depths greater than 10 feet bgs. This finding is attributed to the fact that deep soil within the East Adjacent Area consists of either natural sediments or fill material placed during expansion of the shipyard in the early 1940s.

The heterogeneous distribution of solid waste and soil contamination makes delineation of potential areas of concern problematic; however, past characterization efforts have provided sufficient data to evaluate potential risks to humans and wildlife at Parcel E-2 because past sampling locations have focused, to the extent practical, on the most likely contaminant sources (based on a comprehensive review of historic aerial photographs and any visual evidence of contamination).

ES.2.4. Groundwater

Groundwater contamination has been confirmed through sampling across Parcel E-2 in both the A-aquifer and uppermost B-aquifer. The lateral and vertical extent of chemicals in groundwater has been defined across most of Parcel E-2 through a series of investigations and the ongoing groundwater monitoring program. The extent of chemicals in groundwater, however, is not completely defined along the Parcel E-2 shoreline. In 2008, a focused data gaps investigation was performed along the Parcel E-2 shoreline, and results of the investigation helped to identify areas requiring further evaluation in the FS

portion of this report. Primary potential migration pathways for contaminated groundwater include migration and discharge of A-aquifer groundwater into San Francisco Bay and wetlands and migration of A-aquifer groundwater (including the saturated waste layer) into the uppermost B-aquifer.

The primary groundwater analytical groups at Parcel E-2 include metals, SVOCs, VOCs, pesticides, PCBs, petroleum hydrocarbons, and anions (such as ammonia and cyanide). Groundwater sampling results indicate that the concentrations and extent of contamination in the uppermost B-aquifer are less than observed in the A-aquifer due to the hydrogeologic and geologic characteristics (presence of Bay Mud) across most of Parcel E-2. Overall, the number of detected chemicals and the magnitude of the concentrations detected in both aquifers has declined between 1990 and 2007.

ES.2.5. Surface Water

Potential exposure of wildlife to unacceptable chemical concentrations in surface water runoff is monitored in accordance with a Stormwater Discharge Management Program (MARRS Services, Inc. [MARRS] and MACTEC Engineering and Consulting [MACTEC], 2008b). Results to date indicate no incidents of noncompliance at Parcel E-2 except in isolated locations where best management practices (BMPs) require modification to better control erosion and sediment transport from neighboring properties (TtEMI, 2004d; AFA Construction Group and Eagle Environmental Construction [EEC], 2005a; EEC, 2006 and 2007; MARRS and MACTEC, 2008a). The ongoing maintenance of the interim cap and implementation of BMPs serves to minimize erosion from surface water runoff and potential exposure to wildlife. Continued management (through implementation of BMPs) and monitoring of surface water runoff should be evaluated as part of any remedial alternative that leaves contaminated soil in place.

ES.2.6. Shoreline Sediment

Potential risks to wildlife, specifically benthic invertebrates, birds, and mammals, exposed to intertidal sediments at Parcel E-2 were evaluated in a screening-level ecological risk assessment (SLERA) prepared in conjunction with the Shoreline Characterization Technical Memorandum (included as Appendix G in this RI/FS Report). Concentrations of chemicals in surface and subsurface sediment samples collected from the Shoreline Area were screened against toxicological benchmarks for invertebrates, birds, and mammals.

The shoreline SLERA concluded that concentrations of copper and lead in sediment along the Parcel E-2 shoreline are a potential source of contamination to Parcel F. In addition, benthic invertebrates, birds, and mammals are at risk from exposure to PCBs in surface sediments along the Parcel E-2 shoreline.

Source control measures are warranted along the Parcel E-2 shoreline, particularly in the Metal Slag Area of the Panhandle Area and the Landfill Area, to control potential releases of copper and lead to Parcel F. In addition, ecological risk to benthic invertebrates, birds, and mammals in the shoreline warrants the evaluation of remedial alternatives for intertidal sediments along the entire Parcel E-2 shoreline.

ES.3. RISK ASSESSMENTS

Potential risks to humans and wildlife were evaluated for the following contaminated media: (1) soil; (2) landfill gas; (3) groundwater; and (4) shoreline sediment. The human health risk assessment (HHRA) was performed in accordance with the protocols and procedures for conducting HHRAs at HPS established by the Base Realignment and Closure Cleanup Team. SLERAs for soil and sediment were performed in accordance with Navy policy and EPA guidance (Navy, 1999; EPA, 1997).

ES.3.1. Soil

Human Health Risk Assessment

The HHRA calculated cancer risks and noncancer hazards from exposure to chemicals of potential concern (COPCs) in soil for recreational users and construction workers. The recreational use evaluated in the HHRA is consistent with the planned open space reuse at Parcel E-2. As discussed in Section ES.1, land uses other than open space are incompatible with the landfill area, and institutional controls such as restrictive covenants will address this incompatibility. Both total and incremental risks were evaluated for exposure to soil at Parcel E-2. The total risk evaluation provides an estimate of the risks posed by all chemicals at the site, including those present at concentrations at or below Hunters Point ambient levels (HPALs). The incremental risk evaluation provides an estimate of risks posed by all chemicals at the site, except those that do not exceed HPALs. A risk characterization analysis, of both total and incremental risk, identified the following chemicals of concern (COCs) that contribute to cancer risks exceeding 1×10^{-6} or noncancer hazard indices exceeding 1.0:

Chemicals of Concern		
Construction Worker Exposure [a] to Subsurface Soil (0 to 10 feet bgs)	Recreational User Exposure [b] to Surface Soil (0 to 2 feet bgs)	
4,4-DDT	Antimony	Indeno(1,2,3-cd)pyrene
Antimony	Aroclor-1242	Lead
Aroclor-1016	Aroclor-1248	Total PCBs (non-dioxin)
Aroclor-1242	Aroclor-1254	
Aroclor-1248	Aroclor-1260	
Aroclor-1254	Arsenic	
Aroclor-1260	Benzo(a)anthracene	
Arsenic	Benzo(a)pyrene	
Benzo(a)anthracene	Benzo(b)fluoranthene	
Benzo(a)pyrene	Benzo(k)fluoranthene	
Benzo(b)fluoranthene	Dieldrin	
Benzo(k)fluoranthene	Heptachlor epoxide	

Note: COCs for total risk and incremental risk are identical
a The construction worker exposure scenario is not associated with a specific planned reuse for Parcel E-2.
b COCs identified for this exposure scenario are based on the planned reuse for Parcel E-2 as open space.
DDT Dichlorodiphenyltrichloroethane

The highest cancer and noncancer risks were at grid cells where the western and southwestern sidewall of the PCB Hot Spot Area excavation is located. Risk in these grid cells was reduced slightly following the removal action; however, remaining chemical concentrations along the western and southwestern sidewall of the PCB Hot Spot Area excavation continue to drive risk.

Screening-Level Ecological Risk Assessment

The Navy implemented the following steps to update previous ecological assessments with recent data collected during the soil data gaps investigation and following removal actions at the Metal Slag Area and the PCB Hot Spot Area: (1) evaluated the new data set to validate the list of chemicals of potential ecological concern (COPECs) used in the previous baseline ecological risk assessment for terrestrial receptors; (2) identified additional chemicals as COPECs and calculated protective soil concentrations (PSCs) for these additional chemicals; and (3) updated the previous ecological assessments by performing a SLERA for onshore ecological receptors using the updated PSCs and surface soil data set. The onshore SLERA evaluated all soil data within the Landfill Area, Panhandle Area, and East Adjacent Area, including data collected within wetland areas. Concentrations of cadmium, copper, lead, manganese, mercury, nickel, vanadium, zinc, polycyclic aromatic hydrocarbons, total DDT, and total PCBs exceeded PSCs (adjusted by HPALs, as appropriate) and are chemicals of ecological concern (COECs) that pose a potential threat to birds and mammals exposed to soil in Parcel E-2.

ES.3.2. Landfill Gas

Human exposure to subsurface air emanating from the landfill (referred to as landfill gas) can pose a potential risk in two ways: (1) explosive conditions due to concentrations of methane at or above the LEL; and (2) inhalation of NMOCs that, above certain concentrations, have associated cancer and noncancer health effects. Evaluation of these potential risks was performed consistent with regulations outlined in Title 27 California Code of Regulations (CCR).

For the landfill gas characterization, the evaluation methodology for methane data involved comparing field and laboratory data collected from the monitoring network against the numeric 27 CCR limits. The evaluation methodology for NMOCs involved performing risk assessments on soil gas data using the Johnson and Ettinger vapor intrusion model (EPA, 2003a). Cancer risk calculations for GMPs along Crisp Avenue and within the UCSF compound were less than the NCP point of departure of 1×10^{-6}; therefore, soil gas along Crisp Avenue and within the UCSF compound does not pose an unacceptable risk to human health.

Based on evaluation of available data from January 2004 through September 2008, the gas control system is controlling the migration of hazardous levels of landfill gas beyond the northern fence line of the Parcel E-2 Landfill. In January and February 2006, hazardous levels of landfill gas were detected at the fence line of the landfill. The Navy promptly performed active extraction to control the migration of hazardous levels of landfill gas beyond the fence line of the landfill. The potential exists for landfill gas,

if not properly controlled, to migrate beyond the Parcel E-2 Landfill boundary at concentrations that may be hazardous to human health.

ES.3.3. Groundwater

Human Health Risk Assessment

For the evaluation of human exposure to groundwater, the HHRA used groundwater monitoring data from the 12 most recent sampling events (through October 2007) from all Parcel E-2 wells to develop a conservative exposure concentration for each potentially complete pathway (based on the 95 percent upper confidence limit). The HHRA evaluated B-aquifer groundwater for domestic use; the evaluation used both B-aquifer and A-aquifer data because of the potential for vertical hydraulic communication between the A- and B-aquifers in some areas at Parcel E-2. In addition, construction workers were also assumed to be exposed to groundwater in the A-aquifer during trenching activities. For groundwater exposures, risks are the same for the total risk and incremental risk evaluations because a comparison to ambient levels was not conducted for groundwater.

The primary risk drivers for the construction worker trench exposure scenario are SVOCs, primarily benzo(a)pyrene and dibenz(a,h)anthracene, which account for more than 95 percent of the total cancer risk exceeding 1×10^{-6}. However, benzo(a)pyrene and dibenz(a,h)anthracene have not been detected in Parcel E-2 groundwater since August 2002. In addition, the extent of most SVOCs in Parcel E-2 groundwater has been localized, with maximum concentrations detected at former well IR01MWI-3 in the PCB Hot Spot Area excavation.

The primary risk drivers for the domestic use of the groundwater exposure scenario are arsenic and PCBs, accounting for over 70 percent of the total cancer risk exceeding 1×10^{-6}. Another risk driver that contributes significantly to the total cancer risk is benzo(a)pyrene, which accounts for approximately 13 percent of the total cancer risk exceeding 1×10^{-6}. The risk evaluation also indicated that the primary noncancer risk drivers include metals (arsenic, iron, hexavalent chromium, and thallium), 4-nitrophenol, and PCBs, which account for over 85 percent of the noncancer risk exceeding a hazard index of 1.0.

Ecological Risk Assessment

A screening-level assessment of ecological risk to aquatic wildlife exposed to potentially contaminated groundwater at Parcel E-2 is provided in Appendix M. Chemical concentrations in groundwater were screened against the assigned aquatic evaluation criteria, mainly comprising saltwater aquatic criteria, to identify COPECs for surface water quality. Site-specific data for select COPECs were then evaluated against trigger levels, consistent with the methods used in recent FS reports at other HPS parcels, to further confirm if the COPECs needed to be addressed in remedial alternatives. Based on concentrations exceeding trigger levels (as adjusted based on HGALs), the following chemicals (or groups of chemicals) pose a potential threat to aquatic wildlife exposed to potentially contaminated groundwater at Parcel E-2:

- Copper
- Lead
- Zinc
- Un-ionized Ammonia
- Sulfide
- Cyanide
- PCBs (Total)
- Total petroleum hydrocarbons (TPH)

ES.4. REMEDIAL INVESTIGATION CONCLUSIONS

Parcel E-2 has been adequately characterized to support the development of a focused set of remedial alternatives. The conclusion that adequate data exist, despite the areas where chemicals in soil and groundwater are not completed delineated, is consistent with EPA RI/FS guidance. Specifically, EPA RI/FS guidance states that "the objective of the RI/FS process is not the unattainable goal of removing all uncertainty, but rather to gather information sufficient to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site" (EPA, 1988a).

Based on the nature and extent evaluation, the identified exposure pathways based on the conceptual site model, and the risk assessment results, the following media and affected areas pose potential threats to human health and the environment and will undergo remedial option analysis in the FS: (1) solid waste and soil in the Landfill Area; (2) landfill gas; (3) soil and isolated solid waste in the Panhandle and East Adjacent Areas; (4) A-aquifer and B-aquifer groundwater; (5) surface water runoff; and (6) shoreline sediment.

ES.5. FEASIBILITY STUDY

The approach used to conduct the FS consisted of the following steps: develop remediation goals, develop RAOs, identify general response actions (GRAs), identify areas requiring remediation, and evaluate alternatives based on the nine NCP evaluation criteria. Each of these steps is discussed in the following paragraphs.

ES.5.1. Remediation Goals

Humans

Remediation goals for humans were derived for each COC identified in the risk assessments by comparing the highest concentrations of acceptable incremental risk with both the laboratory's reporting limit and the ambient level for the COC, if one was established. The greatest value from this comparison was selected as the remediation goal for that COC. For landfill gas, remediation goals were derived using the numeric 27 CCR limits for methane and by identifying screening levels for NMOCs that are considered protective of human health.

Wildlife

Remediation goals for wildlife were derived for COECs identified from the nature and extent evaluation and the risk assessments. For surface soil and shoreline sediment, remediation goals were derived using the corresponding PSCs (for soil) and effects range-median values (for shoreline sediment) developed as part of the risk assessment process. For surface water runoff, remediation goals were derived using promulgated criteria for saltwater aquatic life. Saltwater aquatic criteria were used in a screening-level evaluation of groundwater discharges; however, the identified chemicals in groundwater that may pose a risk to aquatic wildlife in San Francisco Bay are considered COPECs (that is, of chemicals of potential ecological concern) given the conservative nature of the risk analysis performed for that pathway. As such, groundwater remediation goals have not been developed for these COPECs. The remedial alternatives evaluate areas affected by these COPECs, the remediation technologies to be evaluated (include source removal, containment, and monitoring) are considered adequate to address the potential risk to aquatic wildlife in the bay.

In addition, remediation goals were established for TPH that are commingled with CERCLA-regulated chemicals. The TPH remediation goals were based on criteria established for Hunters Point petroleum program and were developed for protection of aquatic wildlife in the bay. The TPH criteria sum all TPH categories (gasoline-range, diesel-range, and motor-oil range). The total TPH groundwater criterion ranges from 1,400 to 20,000 micrograms per liter, depending on the distance from the shoreline (Shaw Environmental, Inc. [Shaw], 2007). The total TPH soil source criterion is 3,500 milligrams per kilogram, and is applied to potential soil sources between 0 and 10 feet bgs (Shaw, 2007).

ES.5.2. Remedial Action Objectives

RAOs for Parcel E are medium-specific goals that were developed to protect human health and the environment. Each RAO specifies: (1) the chemical(s) of concern; (2) the exposure route and receptor(s); and (3) an acceptable chemical concentration or range of concentrations for medium of concern. The following table summarizes the RAOs developed for Parcel E-2.

Media / Receptor	Remedial Action Objective
Waste, Soil, and Sediment / Humans	Prevent exposure to organic and inorganic chemicals at concentrations greater than remediation goals in (1) solid waste, soil, or sediment from 0 to 2 feet bgs by recreational users; or (2) solid waste, soil, or sediment from 0 to 10 feet bgs by construction workers.
Waste, Soil, and Sediment / Wildlife	Prevent exposure of wildlife to organic and inorganic chemicals in solid waste or soil at concentrations greater than remediation goals from 0 to 3 feet bgs throughout Parcel E-2. Prevent exposure of wildlife to organic and inorganic chemicals in intertidal sediment at concentrations greater than remediation goals from 0 to 2.5 feet bgs throughout the Shoreline Area.

Media / Receptor	Remedial Action Objective
Landfill Gas	Control methane concentrations to (1) 5 percent (by volume in air) or less at subsurface points of compliance; and (2) 1.25 percent (by volume in air) or less in on-site structures. Prevent exposure to NMOCs at concentrations (1) greater than 500 parts per million by volume (ppmv) at the subsurface points of compliance; and (2) greater than 5 ppmv above background levels in the breathing zone of on-site workers and visitors.
Groundwater / Humans	Prevent exposure to groundwater that may contain COCs at concentrations greater than remediation goals through the domestic use pathway. Prevent or minimize migration of B-aquifer groundwater that may contain COCs at concentrations greater than remediation goals beyond the compliance boundary. Prevent or minimize dermal contact to and vapor inhalation from A-aquifer groundwater containing COCs at concentrations greater than remediation goals by construction workers.
Groundwater / Wildlife	Prevent or minimize migration of COPECs to prevent discharge that would result in concentrations greater than the corresponding water quality criteria for aquatic wildlife. Prevent or minimize migration of A-aquifer and B-aquifer groundwater containing total TPH concentrations greater than the remediation goal (where commingled with CERCLA substances) into San Francisco Bay.
Surface Water / Wildlife	Prevent or minimize migration of surface water that may contain COECs at concentrations greater than water quality criteria for aquatic wildlife into San Francisco Bay.

ES.5.3. General Response Actions, Remedial Technologies, and Process Options

GRAs are responses or remedies intended to meet RAOs. The following GRAs were selected for Parcel E-2:

1. No action – which is required by the NCP and is used as a baseline for comparison
2. Institutional actions – includes institutional controls, engineering controls, and site monitoring
3. Containment actions (with or without collection, treatment, and disposal) – includes technologies that isolate media to reduce or eliminate exposure to, and off-site migration of, surface and subsurface contaminants
4. Removal actions – includes removal of contaminated media for treatment and disposal on or off site; exposure risk and migration potential are diminished by eliminating or reducing the contaminant source

The technologies and associated process options identified for each GRA were screened using three criteria: (1) effectiveness; (2) implementability; and (3) cost. Screening of the technologies and process options for each GRA is summarized in Figure ES-2. The Landfill Area meets all of the criteria specified in EPA guidance for application of the containment presumptive remedy. However, based on feedback from members of the local community, the Navy has agreed to fully evaluate excavation of the landfill as

part of the FS to provide information to support the community's review of potential remedial alternatives for Parcel E-2. Therefore, removal by excavation and off-site disposal was retained as a potentially viable process option for the Landfill Area. For the Panhandle, East Adjacent, and Shoreline Areas, process options related to both containment and removal were retained for development of remedial alternatives.

Implementation of any containment or removal action that would alter existing site conditions will affect Parcel E-2 wetlands. Compliance with regulations for wetlands protection (in accordance with the Clean Water Act [§ 404] and the San Francisco Bay Plan [14 CCR, §§ 10110 through 11990]) will require that such effects be addressed through the established wetlands mitigation process. The following mitigation approaches have been identified: (1) wetlands banking; (2) wetlands restoration within HPS at areas not affected by COCs or COECs; and (3) wetlands restoration in the Panhandle Area of Parcel E-2.

ES.5.4. Development of Remedial Alternatives

The following remedial alternatives were developed for Parcel E-2 from the technologies and process options retained for each GRA:

- **Alternative 1 – No Action:** For this alternative, no remedial action would take place. Solid waste, soil, sediment, groundwater, and surface water would be left in place without any response actions (such as, institutional controls, monitoring, containment, removal, and treatment). The no action alternative is retained throughout the FS process as required by the NCP to provide a baseline for comparison with and evaluation of other alternatives.
- **Alternative 2 – Excavate and Dispose of Solid Waste, Soil, and Sediment (including monitoring and institutional controls):** This alternative would involve excavation and off-site disposal of all solid waste, debris, and soil in the Landfill Area. Isolated solid waste locations, soil, and sediment in the adjacent areas (which consist of the Panhandle Area, East Adjacent Area, and Shoreline Area) would also be excavated and disposed of off site. Groundwater monitoring would be included under this alternative to evaluate chemical concentrations in groundwater while the aquifers naturally recover. Additionally, groundwater monitoring would be used to confirm site conditions and to ensure that, over time, the potential exposure pathways would remain incomplete. This alternative would also include institutional controls (consisting of land use and activity restrictions) that would be implemented across the entire parcel to prevent exposure to COCs and COECs in soil and groundwater. Wetlands disturbed during excavation activities would be restored on top of the clean fill in the Panhandle Area.
- **Alternative 3 – Contain Solid Waste, Soil, and Sediment with Hot Spot Removal (including monitoring and institutional controls):** This alternative would involve (1) excavation and off-site disposal of all radiological surface anomalies and Tier 1 and Tier 2 hot spots in the Panhandle Area, East Adjacent Area, and Shoreline Area; and (2) excavation and on-site consolidation of soil in portions of the Panhandle Area planned for wetlands restoration (both tidal and freshwater) and sediment throughout the Shoreline Area. Excavation activities would be followed by containment of solid waste and soil in the Landfill, Panhandle, East Adjacent, and Shoreline Areas. The portions of the Landfill Area not already covered by the existing multilayer cap would be covered with a similarly designed multilayer cap. The isolated solid waste locations and soil in the East Adjacent Area, as well as portions of the Panhandle and Shoreline Areas not

planned for tidal wetlands restoration, would be covered with a geosynthetic cap. The cap termination within the Shoreline Area would be protected with a shoreline protection system and, where the Landfill Area abuts the Shoreline Area, would also be underlain by a subsurface drainage system (in the event that groundwater monitoring results prompt extraction and treatment of leachate and contaminated groundwater). In addition, this alternative would include (1) construction of a groundwater diversion system (consisting of an upgradient slurry wall and subsurface drain) along the west side of the landfill to divert upgradient groundwater and reduce leachate generation; (2) installation, operation, and maintenance of an active landfill gas control system; (3) monitoring of landfill gas, stormwater, and groundwater; and (4) institutional controls (consisting of land use and activity restrictions) that would be implemented across the entire parcel to prevent exposure to COCs and COECs in soil, landfill gas, and groundwater. Also, freshwater wetlands disturbed during construction of the containment systems would be restored on top of the cap in the Panhandle Area, while tidal wetlands disturbed during construction would be restored without a cap.

- **Alternative 4 – Contain Solid Waste, Soil, Sediment, and Groundwater with Hot Spot Removal (including monitoring and institutional controls):** This alternative would have the same components as Alternative 3, but would include (1) excavation and off-site disposal of Tier 3, 4, and 5 hot spots (in addition to Tier 1 and 2 hot spots; (2) containment of contaminated groundwater with a slurry wall in the nearshore areas where landfill waste is within 100 feet of San Francisco Bay (referred to as the "nearshore slurry wall"); and (3) a contingency to extend the nearshore slurry wall south into the PCB Hot Spot Area. The need for this extension will be assessed in the RD using updated groundwater monitoring data from wells in and around the excavated portion of the PCB Hot Spot Area. The groundwater diversion system along the west side of the landfill, as proposed under Alternative 3, would minimize hydraulic head buildup behind the nearshore slurry wall.

ES.5.5. Detailed Evaluation of Remedial Alternatives

Each remedial alternative was evaluated in comparison to the two threshold and five balancing evaluation criteria established in the NCP. The two modifying criteria, state and community acceptance, will be assessed in the ROD following comment on the RI/FS Report and the proposed plan. A comparative analysis was then conducted to evaluate the relative performance of the three remedial alternatives developed for Parcel E-2.

NCP EVALUATION CRITERIA

Threshold Criteria
- Overall protection of human health and the environment
- Compliance with applicable or relevant and appropriate requirements

Balancing Criteria
- Long-term effectiveness and permanence
- Reduction of mobility, toxicity, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost

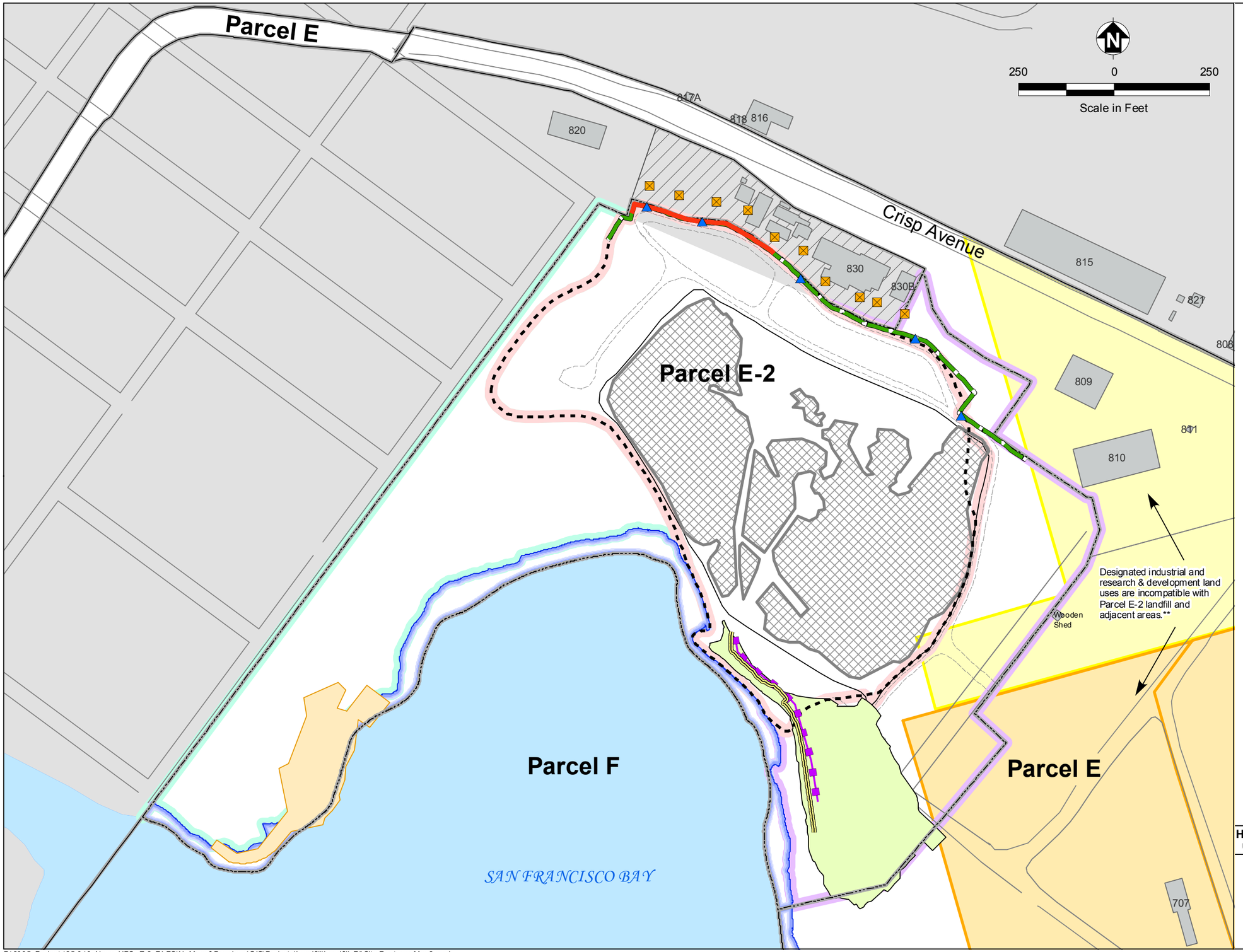
Modifying Criteria
- State acceptance
- Community acceptance

ES.5.6. Comparative Analysis of Remedial Alternatives

Table ES-1 summarizes the comparative analysis; showing each alternative's rating under the three threshold criteria and five balancing criteria. The no action alternative (Alternative 1)

would not be effective in protecting human health and the environment. Alternatives 2, 3, and 4 would be effective remedial alternatives for Parcel E-2. Alternatives 3 and 4 appear to be significantly more feasible, predictable, cost-effective, time-effective, and implementable remedies, when compared with Alternative 2. Alternative 4 offers improved long-term effectiveness but has a higher cost relative to Alternative 3. The remedy for Parcel E-2 will be selected in the ROD following comment on the RI/FS Report and the proposed plan.

Figures



LEGEND

- Burn Area
- Parcel E-2 Boundary
- Parcel Boundary
- Estimate of Soild Waste Extent
- Landfill Area
- East Adjacent Area
- Panhandle Area
- Shoreline Area
- Non-Navy Property
- UCSF Compound
- Building
- San Francisco Bay
- Road
- Gravel Road

Reuse Category

- Industrial
- Research and Development

Removal Actions

- Interim Landfill Cap
- Metal Slag Area (final boundary)
- PCB Hot Spot Area (final boundary)

Groundwater Extraction System

- Sheet-Pile Wall
- Extraction Trench

Interim Landfill Gas Control System

- Extraction Well
- Passive Vent
- HDPE Barrier Wall
- Grouted Section of HDPE Barrier Wall That Can Be Used For Extraction

Notes:

HDPE = high density polyethylene
PCB = polychlorinated biphenyls
TCRA = Time-Critical Removal Action
Post- excavation boundaries in PCB Hot Spot Area and Metal Slag Area are consistent with information presented in final removal action completion reports.

**To address this incompatibility, land use controls such as restrictive covenants that limit land use to open space development will be incorporated into remedial alternatives, as appropriate.

ERRG ENGINEERING/REMEDIATION RESOURCES GROUP, INC.

Hunters Point Shipyard, San Francisco, California
U.S. Department of the Navy, BRAC PMO West, San Diego, California

FIGURE ES-1

PARCEL E-2 LOCATIONS AND REMOVAL ACTION AREAS

Remedial Investigation/Feasibility Study for Parcel E-2

P:\2005_Projects\25-049_Navy_HPS_E-2_RI-FS\N_Maps&Drawings\GIS\Projects\Landfill\Landfill_RI\Site Features Map2.mxd

Medium	General Response Action	Remedial Technology	Process Options	Description	Comments	Effectiveness	Implementability	Cost	Retained for Analysis?
Solid Waste and Soil in Landfill, Panhandle, and East Adjacent Areas; Sediment in Shoreline Area	No Action	None	None	No additional action would be taken to address solid waste and soil in the Landfill Area, Panhandle Area or East Adjacent Area, or sediment in the Shoreline Area.	Required by the NCP and is used as a baseline against which other response actions are compared - would not meet RAOs.	Low	High	No Cost	Yes
	Institutional Actions	Institutional Controls	Legal Mechanisms (Restrictive Covenants, Negative Easements, Deed Notifications); Administrative Mechanisms (Land Use Plans, Soil & Groundwater Procedures & Policies, Construction Permitting, Public Notices & Educational Materials)	Legal and administrative mechanisms used in combination to enforce various land use restrictions such as: • Restrict the use of the parcel to open space • Require maintenance of control systems • Maintain the integrity of covers (or access restrictions where covers are not present) • Require development of a soil and groundwater management plan to be implemented during all intrusive site activities (such as, subsurface construction)	Institutional controls would be integral to and highly effective at maintaining the integrity of any final remedy, and are likely to be included as a part of any alternative that leaves landfill solid waste or other hazardous substances in place.	High	High	Low	Yes
		Engineering Controls (i.e. to limit/restrict access)	Signs (Warning & No Trespassing); Traffic Barriers & Perimeter Fencing	Engineering controls are physical mechanisms that serve to restrict access and potential exposure to contaminated media. Process options include warning and no trespassing signs, engineered barriers to vehicular traffic and perimeter fencing to reduce the potential for direct human contact with contaminated media.	Access restrictions conflict with future open space reuse; to be used during implementation of other remedial technologies.	Low (if used as part of a permanent remedy) High (if used during implementation of an active remediation technology)	Low (if used as part of a permanent remedy) High (if used during implementation of an active remediation technology)	Low	No (to be used in conjunction with other remediation technologies)
		Site Monitoring	Short-Term Monitoring; Long-Term Monitoring	Short-term monitoring involves outdoor air monitoring during construction that may disturb contaminated solid waste, soil, or sediment. Long-term monitoring includes operation and maintenance of control systems (such as, inspection and maintenance of caps/covers).	Although monitoring alone would not achieve RAOs, short-term and long-term monitoring would be integral components in any remedial alternative implemented at Parcel E-2.	Low	High	Low	Yes
	Containment	Caps/Covers	Low-Permeability Soil Cap	The low-permeability soil cap system (Title 27 cover, prescriptive standard) includes a low-permeability soil layer (such as clay) at least 12 inches thick with a maximum permeability of $1x10^{-6}$ cm/sec or equal to the hydraulic conductivity of the base liner system.	No local source of low-permeability soil; costly to purchase and import suitable low-permeability soils.	High	Moderate-High	Moderate-High	No
			Geosynthetic Cap	The geosynthetic cap system (Title 27 cover, engineered alternative) would include a 60-mil-thick HDPE geomembrane in place of the low-permeability soil layer (typical permeability is $1x10^{-13}$ cm/sec)	Highly effective and implementable with proper QA/QC, skilled labor, and appropriate supplies and equipment.	High	High	Moderate	Yes
			Multilayer Geosynthetic Cap	The multilayer geosynthetic cap system includes a composite low-permeability layer consisting of an HDPE geomembrane at least 60 mils thick over a GCL (typical permeability of GCL is $5x10^{-9}$ cm/sec)	Already installed over a portion of the waste area; highly effective and implementable with proper QA/QC, skilled labor, and appropriate supplies and equipment.	High	High	Moderate-High	Yes
			Evapotranspiration Cap	An evapotranspiration cap is typically a 4- to 6-foot-thick soil layer over a soil foundation layer; it acts to store moisture within the cap thickness, while minimizing infiltration, until the moisture is removed through vegetative uptake or evaporation.	Diminished effectiveness in temperate climates; ideal in arid or semi-arid climates; would require importation of a significant amount of cover soil and may encroach on neighboring property.	Moderate	Low	Moderate to High	No
		Shoreline Protection *	Armoring	Armoring includes seawalls, bulkheads, and protective revetments.	Armoring would protect the containment systems from erosion, and allow freshwater wetlands to be established in the Panhandle Area.	High	High	High	Yes
			Shoreline Stabilization	Shoreline stabilization includes man-made structures (such as nearshore breakwaters and reefs) or natural material (such as vegetation or sand fill) used to moderate the coastal sediment transport processes and reduce the local erosion rate.	Shoreline stabilization would be effective In areas planned for tidal wetlands restoration.	Moderate	High	Moderate to High	Yes
			Shoreline Nourishment	Shoreline nourishment can include berms, dunes, feeder beach, nearshore berm, dune stabilization, or structural stabilization.	Inadequate area for proper implementation; would not prevent erosion.	Low	High	Moderate	No
	Removal	Excavation	Excavation/Off-Site Disposal 1. Landfill Area 2. Soil in adjacent areas	Excavation and off-site disposal of all solid waste and contaminated soil in the Landfill Area, and contaminated soil/sediment in Panhandle, East Adjacent, and Shoreline Areas that may pose a risk to human health and the environment	Multiple issues associated with excavation and transport of such a large volume of landfill solid waste and soil.	Moderate-High	Low-Moderate	Very High	Yes (to support community review of potential remedies)
			Excavation/Off-Site Disposal 1. Hot spots in adjacent areas 2. Incidental LLRW	Excavation and off-site disposal of hot spots in Panhandle, East Adjacent, and Shoreline Areas (including LLRW encountered during hot spot excavation activities)	Primary hot spots consist of liquid and highly toxic wastes in the PCB Hot Spot shoreline; additional removal at other locations in the Panhandle and East Adjacent Areas to enhance performance of remedy..	High	High	Moderate to High	Yes
			Excavation/On-Site Consolidation of hot spots in adjacent areas (with off-site disposal of incidental LLRW)	Excavation of hot spots in Panhandle, East Adjacent, and Shoreline Areas with off-site disposal of LLRW and on-site consolidation of non-radiological hot spot material	Hot spots are not mobile and planned leachate collection/treatment system is considered adequate but not as robust as off-site disposal facilities	Moderate	Moderate	Moderate	No
			Excavation/On-Site Consolidation of contaminated material in adjacent areas (with off-site disposal of incidental LLRW)	Excavation of solid waste and contaminated soil/sediment in Panhandle, East Adjacent, and Shoreline Areas, as needed to meet design requirements of a containment process option (for example, stable slopes along shoreline and altered topography to support wetlands restoration), with off-site disposal of LLRW and on-site consolidation of non-radiological material	Specific hot spot removal areas include surface soils in the Metal Slag Area, soils along the PCB Hot Spot shoreline, soils along the Landfill Area Shoreline, and soils from various inland locations in the Panhandle and East Adjacent Areas.	High	High	Moderate	Yes

Legend

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- Eliminated from consideration

Notes:

* Required in Shoreline Area

Acronyms defined on page 4

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FIGURE ES-2
Results of Remedial Technologies and Process Options Evaluation

Remedial Investigation/Feasibility Study for Parcel E-2

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Medium	General Response Action	Remedial Technology	Process Options	Description	Comments	Effectiveness	Implementability	Cost	Retained for Analysis?
Landfill Gas in Parcel E-2	No Action	None	None	No additional action would be taken to remove or treat landfill gas.	Required by the NCP and is used as a baseline against which other response actions are compared – would not meet RAOs.	Low	High	No Cost	Yes
	Institutional Actions	Institutional Controls	Legal Mechanisms (Restrictive Covenants, Negative Easements, Deed Notifications) Administrative Mechanisms (Land Use Plans, Soil & Groundwater Procedures & Policies, Construction Permitting, Public Notices & Educational Materials)	Legal and administrative mechanisms used in combination to enforce various land use restrictions such as: • Require maintenance of control systems • Ensure compliance with 27 CCR requirements for construction within 1,000 feet of a landfill, such as the requirement for gas control systems on any installed subsurface structures or other areas in which landfill gas may accumulate	Institutional controls would be integral to and highly effective at maintaining the integrity of any final remedy, and are likely to be included as a part of any alternative that leaves landfill solid waste or other hazardous substances in place.	High	High	Low	Yes
		Engineering Controls (i.e. to limit/restrict access)	Signs (Warning & No Trespassing) Traffic Barriers & Perimeter Fencing	Engineering controls are physical mechanisms that serve to restrict access and potential exposure to contaminated media. Process options include warning and no trespassing signs, engineered barriers to vehicular traffic and perimeter fencing to reduce the potential for direct human contact with contaminated media.	Access restrictions conflict with future open space reuse; to be used during implementation of other remedial technologies.	Low (if used as part of a permanent remedy) High (if used during implementation of an active remediation technology)	Low (if used as part of a permanent remedy) High (if used during implementation of an active remediation technology)	Low	No (to be used in conjunction with other remediation technologies)
		Site Monitoring	Short-Term Monitoring Long-Term Monitoring	Short-term monitoring involves outdoor air monitoring during construction that may affect landfill gas migration. Long-term monitoring includes monitoring of gas monitoring probes, subsurface structures, and site structures; also includes operation and maintenance of gas control systems.	Although monitoring alone would not achieve RAOs, short-term and long-term monitoring would be integral components in any remedial alternative implemented at Parcel E-2.	Low	High	Low	Yes
	Containment	Landfill Gas Collection	Passive Venting	A passive system at Parcel E-2 would include a series of venting wells extending from below the historic low water table elevation through the cap and discharging to the atmosphere above the surface of the cap.	Diminished effectiveness at landfills with no bottom and sidewall liner system, or landfills with insufficient buffer space between the edge of waste and the compliance points; if NMOC treatment is required at the discharge points, the required treatment systems could restrict landfill gas venting, rendering venting less effective.	Moderate	High	Low	Yes
			Active Collection	Active landfill gas collection uses vacuum blowers to extract landfill gas through vertical extraction wells installed and plumbed together; gases are drawn to a central collection point to create an inward pressure gradient to prevent outward landfill gas migration.	More effective with geosynthetic caps in shallow landfills because geosynthetic materials offer a better barrier against vacuum short-circuiting to the surface.	High	High	Moderate	Yes
	Treatment (gas treatment and/or destruction) *	Adsorption (via GAC and Hydrosil®)	GAC Hydrosil® (permanganate-impregnated zeolite medium)	GAC would remove SVOCs and most VOCs; could be used with either passive or active collection systems. Hydrosil® would remove lighter VOCs such as vinyl chloride; could be used with either passive or active collection systems.	Treatment units could restrict the airflow of passive venting systems, rendering them less effective.	High	High	Low (if NMOC concentrations are low) High (if NMOC concentrations are high, following capping of the entire landfill)	Yes
		Destruction (via combustion)	Enclosed Flare	An enclosed flare would destroy landfill gas, including NMOCs and methane, through combustion; primary chemical by-products from flares are carbon dioxide and nitrogen oxide compounds.	Operating conditions would reduce the possibility of dioxin formation by promoting the destruction of organics, operating at temperatures above those that would allow dioxin formation followed by rapid quenching, and extending the combustion residence time.	High	Moderate to High	Low to Moderate	Yes
			Open Flare	Eliminated from consideration due to poor system controls (relative to enclosed flares).		N/A	N/A	N/A	N/A
			Internal Combustion Engine	Eliminated from consideration because volume of gas generated by the Parcel E-2 Landfill is not anticipated to be sufficient to support the cost-effective implementation of internal combustion engines.		N/A	N/A	N/A	N/A
		Destruction (via non-combustion processes)	Energy Recovery	Energy recovery technologies, such as fuel cells, use landfill gas to produce energy directly.	Effectiveness of energy recovery and gas-to-product systems at Parcel E-2 is unknown due to the lack of information on gas concentration generation rates (assumed moderate to high, depending on implementability).	Likely Low (assumed moderate to high, if implementable at Parcel E-2)	Likely Low (site-specific conditions need to be better defined)	High	Yes
			Gas-to-Product	Gas-to-product conversion technologies focus on converting landfill gas into commercial products, such as compressed natural gas, methanol, purified carbon dioxide and methane, or liquefied natural gas.					

Legend

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- Eliminated from consideration

Notes:

* Additional data are needed to determine the type(s) of treatment required for landfill gas at Parcel E-2.

Acronyms defined on page 4

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FIGURE ES-2 (cont.)
Results of Remedial Technologies and Process Options Evaluation

Remedial Investigation/Feasibility Study for Parcel E-2

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Medium	General Response Action	Remedial Technology	Process Options	Description	Comments	Effectiveness	Implementability	Cost	Retained for Analysis?
Groundwater in Parcel E-2	No Action	None	None	No action would be taken to remove, contain or treat groundwater; no institutional controls would be established to prevent exposure, and no monitoring would be required.	Required by the NCP and is used as a baseline against which other response actions are compared – would not meet RAOs.	Low	High	No Cost	Yes
	Institutional Actions	Institutional Controls	Legal Mechanisms (Restrictive Covenants, Negative Easements, Deed Notifications)	Legal and administrative mechanisms used in combination to enforce various land use restrictions such as: • Require development of a soil and groundwater management plan to be implemented during all intrusive site activities (such as subsurface construction • Restrict the use of groundwater within the Parcel E-2 boundaries • Prohibit the installation of wells that have the potential to affect the migration of contaminated groundwater within Parcel E-2.	Institutional controls would be integral to and highly effective at maintaining the integrity of any final remedy, and would be required to prevent exposure to groundwater within the Parcel E-2 boundaries.	High	High	Low	Yes
			Administrative Mechanisms (Land Use Plans, Soil & Groundwater Procedures & Policies, Construction Permitting, Public Notices & Educational Materials)						
		Engineering Controls (i.e. to limit/restrict access)	Signs (Warning & No Trespassing)	Engineering controls are physical mechanisms that serve to restrict access and potential exposure to contaminated media. Process options include warning and no trespassing signs, engineered barriers to vehicular traffic and perimeter fencing to reduce the potential for direct human contact with contaminated media.	Access restrictions conflict with future open space reuse; to be used during implementation of other remedial technologies.	Low (if used as part of a permanent remedy) High (if used during implementation of an active remediation technology)	Low (if used as part of a permanent remedy) High (if used during implementation of an active remediation technology)	Low	No (to be used in conjunction with other remediation technologies)
			Traffic Barriers & Perimeter Fencing						
		Site Monitoring	Short-Term Monitoring	Short-term monitoring involves outdoor air monitoring during construction of groundwater control systems. Long-term monitoring includes groundwater monitoring and operation and maintenance of groundwater control systems.	Although monitoring alone would not achieve RAOs, short-term and long-term monitoring would be integral components in any remedial alternative implemented at Parcel E-2.	Low	High	Low	Yes
			Long-Term Monitoring						
	Containment	Physical Barrier	Slurry Wall	Physical barrier would be installed to cut off and/or redirect groundwater flow.	Barrier may need to be complemented with extraction wells or phytoremediation to prevent excessive groundwater mounding.	Moderate to High	Moderate to High	Moderate to High	Yes
			Grout Curtain	Physical barrier would be installed to cut off and/or redirect groundwater flow.	Site-specific conditions limit the implementability of these options.	Moderate to High	Low to Moderate	Moderate to High	No
			Vertical Geomembrane						
			Sheet Pile Wall	Physical barrier would be installed to cut off and/or redirect groundwater flow.	If implemented as a permanent physical barrier, may need to be complemented with a hydraulic barrier to prevent excessive groundwater mounding.	Moderate to High	Moderate to High	Moderate to High	Yes
		Hydraulic Barrier	Flow Diversion Drain	Flow diversion drain coupled with a physical barrier would be installed on the upgradient side of the landfill to reduce groundwater flow through the waste. Drain would divert flow to reduce groundwater mounding behind the physical barrier.	Flow diversion drain is a passive technology requiring no operation, and minimal maintenance after installation.	Moderate to High	High	Low	Yes
			Extraction from Wells & Off-Site Discharge	System would extract groundwater through pumping wells to contain groundwater and achieve RAOs at compliance points; extracted groundwater could be discharged to the sanitary sewer system, treated and reinjected, or treated and discharged to the Bay.	Groundwater modeling would be required to optimize extraction well placement and pumping rates, and to minimize the volume of water pumped from the Parcel E-2 aquifers; the required level of treatment would greatly influence cost.	Moderate to High	High	High	Yes
			Phytoremediation / Phytohydraulics	Phytohydraulics would use of plants to control rainfall infiltration and groundwater levels and movement; plants would remove water through evapotranspiration. In addition to hydraulic control, phytoremediation could potentially help reduce chemical concentrations in subsurface soils and groundwater.	Further studies would be required to identify plant species that could tolerate brackish groundwater, determine required planting area size and plant density. Space requirements may be incompatible with site conditions.	Moderate to High	Low (may increase if used with other technologies)	Low to Moderate	No (further studies required to determine implementability)
		Reactive Barrier	Permeable Reactive Barrier	Permeable reactive barrier would be installed along the shoreline to breakdown contaminants in groundwater flowing off site.	Permeable reactive barrier is a passive technology requiring no operation or maintenance after installation. Technology is unproven for treatment of landfill leachate in a tidal environment.	Undetermined in the short term; Low in the long term	Low	High	No

Legend

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FIGURE ES-2 (cont.)
Results of Remedial Technologies and Process Options Evaluation

Remedial Investigation/Feasibility Study for Parcel E-2

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Medium	General Response Action	Remedial Technology	Process Options	Description	Comments	Effectiveness	Implementability	Cost	Retained for Analysis?
Surface Water in Parcel E-2	No Action	None	None	No action would be taken to monitor or manage stormwater runoff and groundwater discharges to wetlands and the Bay at Parcel E-2; no institutional controls would be established to prevent exposure to surface water.	Required by the NCP and is used as a baseline against which other response actions are compared – would not meet RAOs.	Low	High	No Cost	Yes
	Institutional Actions	Institutional Controls	Legal Mechanisms (Restrictive Covenants, Negative Easements, Deed Notifications)	Legal and administrative mechanisms used in combination to enforce various land use restrictions such as: • Restrict the use of the parcel to open space • Require maintenance of stormwater BMPs • Require development of a soil and groundwater management plan to be implemented during all intrusive site activities (such as, subsurface construction)	Institutional controls would be integral to and highly effective at maintaining the integrity of any final remedy, and are likely to be included as a part of any alternative that leaves landfill solid waste or other hazardous substances in place.	High	High	Low	Yes
			Administrative Mechanisms (Land Use Plans, Soil & Groundwater Procedures & Policies, Construction Permitting, Public Notices & Educational Materials)						
		Engineering Controls (i.e. to limit/restrict access)	Signs (Warning & No Trespassing)	Engineering controls are physical mechanisms that serve to restrict access and potential exposure to contaminated media. Process options include warning and no trespassing signs, engineered barriers to vehicular traffic and perimeter fencing to reduce the potential for direct human contact with contaminated media.	Access restrictions conflict with future open space reuse; to be used during implementation of other remedial technologies.	Low (if used as part of a permanent remedy) High (if used during implementation of an active remediation technology)	Low (if used as part of a permanent remedy) High (if used during implementation of an active remediation technology)	Low	No (to be used in conjunction with other remediation technologies)
			Traffic Barriers & Perimeter Fencing						
		Site Monitoring	Short-Term Monitoring	Short-term monitoring involves stormwater monitoring during construction. Long-term monitoring includes surface water monitoring and inspection and maintenance of stormwater BMPs. Monitoring of surface water is used to demonstrate compliance with RAOs designed to prevent unacceptable exposures to aquatic receptors in the bay.	Although monitoring alone would not achieve RAOs, a stormwater monitoring program, including stormwater BMPs, would be implemented in conjunction with an inspection and maintenance for any containment systems.	Low	High	Low	Yes
			Long-Term Monitoring						
			Stormwater BMPs						

Legend

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Acronyms

BMP	best management practice
CCR	California Code of Regulations
cm/sec	centimeters per second
GAC	granular activated carbon
GCL	geosynthetic clay liner
GRA	general response action
HDPE	high-density polyethylene
LLRW	low-level radioactive waste
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NMOC	nonmethane organic compound
PCB	polychlorinated biphenyl
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
QA	quality assurance
QC	quality control
SVOC	semivolatile organic compound
VOC	volatile organic compound

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FIGURE ES-2 (cont.)
Results of Remedial Technologies and Process Options Evaluation

Remedial Investigation/Feasibility Study for Parcel E-2

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Tables

Table ES-1. Comparative Analysis of Parcel E-2 Remedial Alternatives

Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard, San Francisco, California

ALTERNATIVES	Overall Protection of Human Heath and the Environment [a]	Compliance with ARARs [a]	Long-Term Effectiveness and Permanence	Reduction of Mobility, Toxicity, or Volume through Treatment	Short-Term Effectiveness	Implementability	Cost ($ Million)	Overall Rating by Alternative
Alternative 1: No Action	**No**	**No**	○	○	●	●	**$0**	**NA**
Alternative 2: Excavate and Dispose of Solid Waste, Soil, and Sediment (including monitoring and ICs)	**Yes**	**Meets ARARs**	●	◑	○	○	**$332**	○
Alternative 3: Contain Solid Waste, Soil, and Sediment with Hot Spot Removal (including monitoring and ICs)	**Yes**	**Meets ARARs**	◑	◑	◕	◑	**$74.8 (A) $76.0 (B)**	◑
Alternative 4: Contain Solid Waste, Soil, Sediment, and Groundwater with Hot Spot Removal (including monitoring and ICs)	**Yes**	**Meets ARARs**	◕	◑	◕	◑	**$81.0 (A) $82.2 (B)**	◕

Legend:

- ○ Low
- ◑ Moderate
- ◕ Moderate to High
- ● High

Notes:

a Overall protection of human health and the environment and compliance with ARARs are threshold criteria and alternatives are judged as either meeting or not meeting the criteria.

ARARs applicable or relevant and appropriate requirements
ICs institutional controls
NA not acceptable

ERRG