Section 3. Remedial Investigation Activities and Removal Actions

Multiple environmental investigations have been conducted at Parcel E-2[1], beginning in 1984. These investigations included basewide investigations (such as the IAS), investigations performed throughout Parcel E (which was later subdivided into Parcels E and E-2), and landfill-specific investigations within Parcel E-2. The environmental investigations can be categorized into the following time frames:

Pre-Remedial Investigation Activities (1984 to 1988): The Parcel E-2 Landfill was initially identified as IAS Site 3 during the IAS conducted in 1984 under the NACIP program (NEESA, 1984). Additional investigations performed following the IAS included installation of nine monitoring wells (IR01MWI-1 through IR01MW-9) during the 1987 confirmation study/verification step.

Remedial Investigation Activities (1988 to 1996): The Parcel E-2 Landfill progressed to the RI stage as IR Site 1 and was grouped (along with IR Sites 02 and 03 in Parcel E) into Operable Unit (OU)-I. The first phase of the OU-I RI (from 1988 to 1989) consisted of reconnaissance activities, including a geophysical survey and test pit excavation to delineate the extent of landfill waste, a soil gas survey to evaluate the presence of VOCs in soil and groundwater, and the installation of deep soil borings to define subsurface stratigraphy. Subsequent phases of the OU-I RI involved primary and contingency sampling of soil and groundwater performed from October 1990 to June 1992. Following the 1992 decision to align the HPS IR sites into parcels, the RI at the landfill was completed in conjunction with other Parcel E IR sites, and involved additional field investigation performed from October 1995 to June 1996 (TtEMI, LFR, and Uribe, 1997). In 1993, IR Site 1 was combined with IR Site 21. IR Site 21 was initially identified as a separate site during the RI/FS scoping process, but was later determined to be part of the landfill and thus was combined with IR Site 1.

Data Gaps Investigations (2000 to 2003): During preparation of the Parcel E RI and FS reports in 1997 and 1998, the Navy and regulatory agencies identified additional tasks to support the remedial design for Parcel E, the majority of which were specific to the Parcel E-2 Landfill. These tasks were performed during the NDGI, from October 2001 to September 2002, and included defining the nature and extent of

[1] In September 2004, the Navy divided Parcel E into two parcels (E and E-2). Discussions within this document that reference reports published prior to September 2004 refer to the portion of Parcel E that became Parcel E-2.

landfill gas, refining the lateral extent of solid waste, evaluating liquefaction potential, and delineating wetlands areas adjacent to the landfill. In addition, the Navy and regulatory agencies decided that additional data for Parcel E were needed, including data from the area now referred to as Parcel E-2, to better define the nature and extent of chemicals in soil and groundwater. As discussed in Section 1, these investigations included the GDGI, performed from July 2000 to October 2002, and the SDGI, performed from September 2002 to February 2003.

Landfill Compliance Monitoring (2003 to present): The Navy has implemented several environmental monitoring programs to help satisfy regulatory requirements (as outlined in 27 CCR) for Parcel E-2 until a final remedy is selected. As discussed in Subsection 1.4.5, these programs include landfill gas control and monitoring, groundwater monitoring, landfill-cover integrity monitoring and maintenance, and stormwater management and monitoring. Data from the ongoing monitoring provides information on current site conditions that is helpful in verifying the nature and extent conclusions from previous site investigations.

This RI/FS report is based on information compiled from these past investigations and ongoing monitoring, rather than from a single RI field investigation. Analytical data from pre-RI investigations are not included in the RI data set; however, the results of these investigations were incorporated into the RI field program (TtEMI, LFR, and Uribe, 1997). Table 3-1 summarizes the field activities performed during the RI and subsequent data gaps investigations and compliance monitoring:

In addition, the RI/FS also includes information from several interim removal actions that were performed in Parcel E-2. This section includes brief summaries of the methodologies, actions performed, and relevant results of the investigations and removal actions conducted at Parcel E-2.

Many of the previous investigations were summarized in reports that are drawn upon and either referenced or included as appendices to this report. Previous investigations and other Installation Restoration Program (IRP) activities were divided into the following categories to simplify their presentation in this section: pre-RI activities (Section 3.1), landfill investigations (Section 3.2), soil investigations in non-landfill areas, including the East Adjacent Area and the Panhandle Area (Section 3.3), groundwater investigations (Section 3.4), ecological assessments (Section 3.5), radiological assessments (Section 3.6), outdoor air monitoring (Section 3.7), previous removal actions (Section 3.8), ongoing monitoring programs (Section 3.9), and ongoing removal actions (Section 3.10). A chronology of all previous environmental investigations, as well as previous and ongoing remedial actions conducted at Parcel E-2 is presented in Table 1-3.

3.1. PRE-REMEDIAL INVESTIGATION ACTIVITIES

The pre-RI activities are summarized in the following documents:

- *Geotechnical Investigation, Waste Disposal Sites* (Lowney-Kaldveer Associates, 1973)
- *As-Built Drawings for Storm Sewer Interceptor Phase II, MILCON Project P-261B* (NAVFAC Western Division, 1974)

- *Initial Assessment Study of Hunters Point Naval Shipyard (Disestablished)* (NEESA, 1984)
- *Confirmation Study, Verification Step, Hunters Point Naval Shipyard (Disestablished)* (EMCON Associates [EMCON], 1987a)
- *Area Study for Asbestos-Containing Material and Organic and Inorganic Soil Contamination, Hunters Point Naval Shipyard (Disestablished)* (EMCON, 1987b)
- *Draft Final Parcel E Remedial Investigation Report* (TtEMI, LFR, and Uribe, 1997)

The following subsections are brief summaries of the findings from each of the documents listed above. Unless otherwise indicated, all information included in each summary was derived from the corresponding document listed above.

3.1.1. Geotechnical Investigation, Waste Disposal Sites (1973)

In 1973, Lowney-Kaldveer Associates performed a geotechnical investigation as part of closing the Parcel E-2 Landfill. The field investigation consisted of a surface reconnaissance and a subsurface exploration, including 12 soil borings to depths ranging from 12 to 47 feet bgs. Existing topography and the soil conditions derived from soil samples collected from the borings indicated that the east and west margins of the site were raised with sand and clay fill prior to using the area as a landfill. These fill activities left an inlet of the Bay open that extended through the middle of the waste disposal area.

3.1.2. As-Built Drawings for Storm Sewer Interceptor Project (1974)

Following the disestablishment of HPS as an active naval facility in 1974, several preliminary closure actions were performed at the Parcel E-2 Landfill. A storm water interceptor line was constructed to divert storm water runoff from the hill area north of the landfill to an outfall near Berth 36. This action prevented runoff from inundating the landfill and increasing leachate production. In addition, the landfill was covered with a minimum of 2 feet of compacted imported fill. The fill was placed in two lifts: the first lift varied in thickness but was a minimum of 1 foot and the second lift was 1 foot thick (TtEMI, LFR, and Uribe, 1997).

An oily waste area was also identified on the NAVFAC drawings along the western perimeter of the site (Figure 1-8). Ponded liquid was removed and the top 6 inches of soil at the oily waste area was scarified before placing the soil cover. The soil cover was also graded to facilitate surface water drainage. Drawings also indicate attempts to construct a 1,000-foot-long clay dike along the southern edge of the landfill; however, it did not succeed in attaining an effective seal because of reported difficulty in excavating bulky underground debris (NEESA, 1984).

3.1.3. Initial Assessment Study (1984)

In 1984, WESTEC Services, Inc. (WESTEC) conducted the IAS at IR-01. The IAS consisted primarily of a review of records and a visual inspection of the site. The study concluded that it was highly probable that chemicals from waste disposed of in the Parcel E-2 Landfill had reached the groundwater and were

migrating toward San Francisco Bay. This migration constituted a potential threat to the Bay environment and a confirmation study was recommended for the site.

3.1.4. Confirmation Study, Verification Step (1987)

In 1987, the verification step of the confirmation study was conducted at IR-01. This study consisted of a geophysical survey, the drilling of nine soil borings, and the completion of these borings as monitoring wells (IR01MWI-1 through IR01MW-9). The verification step report concluded that soil at the Parcel E-2 Landfill contained a variety of VOCs and SVOCs that appeared to be associated with petroleum products and some chlorinated organic solvents. The report recommended further environmental investigations due to the detection of contaminants beyond the reported landfill boundaries. It also recommended that, because the results of the gross alpha and beta radiation scans were inconclusive, groundwater should be analyzed for radium and a gamma radiation screening should be performed.

3.1.5. Area Study for Asbestos-Containing Material (ACM) and Organic and Inorganic Soil Contamination (1987)

In 1987, the Area Study for ACM and organic and inorganic soil contamination was conducted throughout HPS to determine if a release of hazardous substances to soil had occurred at construction sites outside the boundaries of previously identified investigation sites. The area study primarily concluded that soils within Study Area A, including Parcels E and E-2, contained naturally-occurring asbestos derived from the serpentine bedrock.

3.1.6. Triple A Machine Shop Investigation, Remedial Action Order, and RI/FS Scoping Document (1986 to 1988)

The Navy leased portions of HPS to Triple A Machine Shop from July 1, 1976 through June 30, 1986. During this period, Triple A used dry docks, berths, machine shops, power plants, offices, and warehouses to repair commercial and naval vessels. The Navy identified 19 sites that Triple A had allegedly used to store and dispose of hazardous and other wastes during its occupancy of the site. Two of these sites, Triple A Sites 1 and 16, are located within Parcel E-2 (Figure 1-11). At Site 16, Triple A allegedly disposed of industrial debris, sandblast waste, oily industrial sand, and asphalt over an area of approximately 5 acres along the shoreline of Parcel E-2 (SFDA, 1986). A portion of the Landfill Area was also included as part of Triple A Site 16. At Site 1, Triple A allegedly stored unlabeled, deteriorating, uncovered drums with their contents exposed to the elements in the southeast corner of Parcel E-2 (SFDA, 1986).

On January 7, 1988, the DHS issued a Remedial Action Order to the Navy and its tenant, Triple A (DHS, 1988). The Remedial Action Order listed numerous sites, including IR Site 1 and Triple A Sites 1 and 16. In response to the Remedial Action Order, the Navy completed a scoping document for the RI/FSs to be conducted at HPS. The scoping document grouped the sites into OUs and described the field investigations to be conducted under the RI (HLA, 1988).

3.2. LANDFILL INVESTIGATIONS

The results of the Parcel E-2 landfill investigations are summarized in the following documents:

- *Draft Final Parcel E Remedial Investigation Report* (TtEMI, LFR, and Uribe, 1997)
- *Final Parcel E Nonstandard Data Gaps Investigation, Landfill Gas Characterization* (TtEMI, 2003e)
- *Final Parcel E Nonstandard Data Gaps Investigation, Landfill Lateral Extent Evaluation* (TtEMI, 2004f)
- *Final Parcel E Nonstandard Data Gaps Investigation, Landfill Liquefaction Potential* (TtEMI and ITSI, 2004b)

The following subsections are brief summaries of the findings from each of the documents listed above. Unless otherwise indicated, all information included in each summary was derived from the corresponding document listed above. The nature and extent of solid waste and subsurface gas in the Landfill Area is discussed in more detail in Subsection 4.2.

3.2.1. Remedial Investigation (1988 to 1996)

The Landfill Area was investigated during the OU-I RI from 1988 to 1992. During the RI, the Navy performed geophysical surveys and excavated test pits to characterize the lateral extent of the landfill waste layer. Figure 3-1 shows the locations of landfill characterization activities, including those performed during the RI. Table 3-2 summarizes the chronology of landfill characterization activities from the RI through the NDGI. In addition, soil borings were installed within the Landfill Area to define the vertical extent of landfill waste, assess the chemical condition of soil fill within the landfill, and evaluate the general composition of the landfill waste. Some of these soil borings were converted into groundwater monitoring wells to assess the chemical conditions of groundwater both within and underneath the landfill waste. Soil and groundwater sampling locations are shown on Figure 3-2. Tables 3-3 and 3-4 summarize the chronology of soil and groundwater sampling activities, respectively.

Data collected during the RI was adequate to define the vertical extent of landfill waste, assess the chemical condition of soil fill within the landfill, and evaluate the general composition of the landfill waste. Following evaluation of the RI results, several data gaps remained within the Landfill Area. The Navy and regulatory agencies decided to conduct a data gaps investigation (referred to as the NDGI) in 2002 to gather more information to characterize the nature and extent of landfill gas, better delineate the lateral extent of waste, and estimate the potential for sand layers near the landfill to liquefy during an earthquake.

3.2.2. Landfill Gas Characterization (2002)

In 2002, as part of the NDGI, the Navy conducted an evaluation to delineate and characterize landfill gas. This included outdoor air monitoring and building atmosphere surveys, a subsurface soil gas survey, and GMP installation and monitoring. Figure 3-1 shows these monitoring locations, and Table 3-2

summarizes the chronology of landfill characterization activities. Results from GMP monitoring indicated that methane, the main component of landfill gas, was present at levels that exceeded the LEL of 5 percent by volume in air in subsurface areas in the northern part of the landfill and aboveground at four areas on the UCSF compound. Trace concentrations of nonmethane organic compounds (NMOCs) were also detected in this area; however, a screening evaluation concluded that the detected levels of NMOCs did not pose an unacceptable risk to human health. The landfill gas characterization report is included as Appendix A to this report.

3.2.3. Landfill Lateral Extent Evaluation (2002)

In 2002, as part of the NDGI, an evaluation of the lateral extent of solid waste was conducted. After a review of the existing historical information, test pits were excavated and soil borings were drilled (Figure 3-1) to determine the edge of the continuous physical waste in the Parcel E-2 Landfill. When solid waste was encountered in a test pit, "step-out" test pits were excavated up to 50 feet from the previous location outward from the center of the landfill. The evaluation determined that the lateral extent of landfill waste encompasses approximately 22 acres (Figure 3-1), and is bounded in most areas by fill composed of soil (mainly sand and gravel) and non-contiguous waste (mainly construction debris and non-hazardous refuse). Along the northern perimeter, the landfill boundary extends to within a few feet of the fence line that separates the landfill and the UCSF compound. The landfill lateral extent evaluation report is included as Appendix B to this report.

3.2.4. Landfill Liquefaction Potential Evaluation (2002)

In 2002, as part of the NDGI, an evaluation was conducted to determine the potential for subsurface layers in the vicinity of the Parcel E-2 Landfill to liquefy during an earthquake. Data collected included visual soil classification from soil borings, standard penetration test (SPT) borings to estimate the relative stiffness and strength (bearing capacity) of soil, cone penetrometer test (CPT) borings to obtain information on soil density and lithology, seismic wave velocity, and laboratory analyses of soil geotechnical characteristics. CPTs and SPTs were performed along the perimeter of the landfill and within the landfill waste (Figure 3-1). The information was used to model the effects of soil liquefaction caused by an earthquake to determine if the integrity of the landfill cover would be compromised.

According to 27 CCR, landfill closure systems must be designed to withstand shaking from the maximum probable earthquake (MPE). The following characteristics apply to the MPE defined based on a deterministic evaluation:

- Location: San Andreas Fault Peninsula Segment
- Magnitude: 7.9
- Distance from site: 12 kilometers
- Peak ground acceleration: 0.5 and 0.6 times the acceleration of gravity

Only certain types of soil (referred to as cohesionless soil) will potentially liquefy under dynamic loading from an earthquake. These types include loosely consolidated soil classified as sand, silty sand, and sandy silt. The artificial fill surrounding and underlying the Parcel E-2 Landfill is heterogeneous and consists of discontinuous layers of cohesionless soils intermixed with cohesive soils (e.g., clay) and landfill waste, and is underlain by the Bay Mud, which consists predominantly of clay with discontinuous layers of sand and silt.

The liquefaction potential of cohesionless soil layers identified within the SPT and CPT borings was evaluated using standard geotechnical methods (Youd and others, 2001; Seed and others, 2001). The evaluation indicated that the majority of these soil layers (66 to 67 percent) would not liquefy during the MPE. The evaluation determined that, for the remaining soil layers that could liquefy during the MPE, lateral movement of soil below the waste may be approximately 4 to 5 feet. This estimate is conservative because of the discontinuous layers and resistance from non-liquefiable soils at the boundaries, which would likely reduce the amount of lateral movement to less than the estimated 4 to 5 feet. Settlement of liquefiable soil below the waste may be up to 10 inches.

The evaluation also concluded that, if containment were selected as the final remediation measure, further analysis would be required on response of the landfill cap, overall stability of the landfill site, slope stability, and other closure features. The landfill liquefaction potential evaluation is included as Appendix C to this report. Additional slope stability analyses are discussed in Subsection 11.5.1.1.

3.3. SOIL INVESTIGATIONS IN NON-LANDFILL AREAS

The non-landfill areas are those beyond the landfill extent but within the Parcel E-2 boundary; these areas are the East Adjacent Area and the Panhandle Area (Figure 1-2). Investigations performed in the intertidal Shoreline Area are discussed in Subsection 3.5. The results of investigations in the East Adjacent Area and the Panhandle Area are summarized in the following documents:

- *Draft Final Parcel E Remedial Investigation Report* (TtEMI, LFR, and Uribe, 1997)
- *Parcels E and E-2 Standard Data Gaps Investigation, Data Summary Report (Revision 01)* (TtEMI, 2005c)
- *Draft Final Removal Action Design and Implementation Work Plan, Metal Debris Reef and Metal Slag Areas, Parcels E and E-2* (TtFW, 2005b)

The following subsections are brief summaries of the findings from each of the documents listed above. Unless otherwise indicated, all information included in each summary was derived from the corresponding document listed above. The nature and extent of chemicals in soil within the East Adjacent Area and Panhandle Area are discussed in more detail in Subsections 4.3 and 4.4, respectively.

3.3.1. Remedial Investigation (1988 to 1996)

From 1988 to 1992, soil within the non-landfill areas was investigated during the OU-I RI. These areas, which lie outside the Landfill and Shoreline Area boundaries but within Parcel E-2, are mainly composed

of fill material, including soil mixed with non-contiguous solid waste deposits. The Navy collected soil samples from surface locations, excavated shallow test pits, and drilled deeper soil and monitoring well borings to determine whether hazardous substances and petroleum hydrocarbons had been released at Parcel E-2. Figure 3-2 shows the soil sampling locations, and Table 3-3 summarizes the chronology of soil characterization activities.

Reconnaissance activities, performed from 1988 to 1989, consisted of drilling deep soil borings to define subsurface stratigraphy and performing a soil gas survey to evaluate the potential presence of VOCs in soil and groundwater. During the soil gas survey at Parcel E-2, concentrations of total petroleum hydrocarbons (TPH), excluding methane and other aliphatic hydrocarbons, were detected in the northern portion of the landfill. In addition, concentrations of less than 1 part per billion (ppb) of trichloroethane (TCA); trichloroethene (TCE); tetrachloroethene (PCE); and benzene, toluene, ethylbenzene, and xylenes (BTEX) were detected (HLA, 1990a). From 1990 to 1992, soil sampling was performed at numerous soil borings and test pits to characterize the nature and extent of chemicals in soil within the East Adjacent Area and Panhandle Area. From 1995 to 1996, additional investigation was performed, as part of the Parcel E RI, to better define the nature and extent of chemicals in soil within the East Adjacent Area.

The RI field work produced sufficient data to identify areas of potential soil contamination in the majority of Parcel E-2. However, following evaluation of the RI results, several data gaps remained within the East Adjacent Area and Panhandle Area. The Navy and regulatory agencies decided to conduct a data gaps investigation (referred to as the SDGI) in 2002 to characterize the landfill/shoreline interface, further delineate known source areas or chemical detections from single-points, and to bound potential sources identified in aerial photographs.

3.3.2. Standard Data Gaps Investigation (2002)

The Navy conducted the onshore SDGI in 2002 to further define the nature and extent of chemicals in soil within the non-landfill areas. The Navy reviewed aerial photographs and logs from test pits, soil borings, monitoring wells, and GMPs from various investigations at Parcel E-2. The Navy then conducted an evaluation that compared soil data to human health and ecological screening criteria and evaluated the visual presence of putrescible solid waste (waste that contains significant quantities of biodegradable material such as wood) beyond the landfill extent. The evaluation identified a number of chemical detections above the SDGI screening criteria, several potential source areas identified in aerial photographs, and several known source areas. In addition, wood debris was identified at several locations outside the Landfill Area that had the potential to generate levels of methane gas above the LEL; however, none of these waste locations were contiguous with the Landfill Area and none of the locations warranted designation as hot spots because they do not contain highly toxic or mobile contaminants.

Onshore sampling locations were selected to bound known or potential source areas and chemical detections from single-points. Soil samples collected from non-landfill areas were tested for metals (including hexavalent chromium), pesticides, PCBs, SVOCs, and TPH (in select locations). The results

were used to delineate the PCB Hot Spot, which was removed under an interim removal action (see Subsection 3.10). Confirmation sampling results from the PCB Hot Spot are not available for this Draft RI/FS, but will be included in the Draft Final RI/FS. The SDGI onshore sampling adequately delineated the extent of chemicals in soil at some areas; however, the SDGI sampling detected concentrations of chemicals above both human health and ecological criteria. This finding is attributed to the heterogeneous nature of the fill material within the Panhandle Area and East Adjacent Area. The nature and extent of chemicals in soil within the Panhandle Area and East Adjacent Area are discussed in more detail in Subsections 4.3 and 4.4, respectively.

In addition to the onshore sampling, the SDGI characterized the nature and extent of chemicals in sediment within, or in close proximity to, the Shoreline Area. The Parcel E-2 shoreline area consists mainly of intertidal sediments between the mean tide line and a riprap wall placed along portions of the shoreline for erosion control. The results of sediment sampling in the Shoreline Area were evaluated in the Shoreline Characterization Technical Memorandum (SulTech, 2005) (Appendix G to this report) and are briefly discussed in Subsection 3.5. In addition to the SDGI sediment sampling, soil along the bayward side of the sheet pile wall was sampled during the SDGI to define the extent of chemicals in soil the interface of the landfill and shoreline. Although these soil sampling locations were considered "shoreline" locations in the SDGI, the locations fall outside of the Shoreline Area as defined for this RI/FS (Figure 3-2) and are considered part of the Landfill Area in this report. Data from these sampling locations were used to delineate the PCB Hot Spot, and were subsequently excavated as part of the removal action.

3.3.3. Characterization of Metal Slag Area (2004)

The Metal Slag Area contains wastes suspected to have originated from the metal foundry (Building 241 in Parcel C) and the smelter (Building 408 in Parcel D) when the shipyard was active. Waste in the Metal Slag Area includes industrial debris and metal slag with radioactive anomalies. In support of the Metal Slag Area removal action, site characterization was performed to further define the vertical and horizontal extent of metal slag. The characterization activities were conducted from June through September 2004 and included: topographic and bathymetric surveys, marine geophysics surveys, landside geophysics surveys, environmental resources surveys, vibracoring and sonic drilling, and sampling activities. The Metal Slag Area was found to contain slag to approximately 15 feet bgs over an area of approximately 0.9 acre. Site characterization activities involved sampling from offshore and onshore borings and analysis for radiological and nonradiological chemical constituents. Elevated levels of cesium-137, metals, PCBs, and pesticides were identified at both sites. The metal slag and debris within the area was removed in 2005 and 2006 (see Subsection 3.10). Confirmation sampling results from the Metal Slag Area are not available for this Draft RI/FS, but will be included in the Draft Final RI/FS.

3.4. GROUNDWATER INVESTIGATIONS

The groundwater data presented in this report were either originally summarized in the three documents listed below, or have been collected as part of the BGMP (Subsection 3.9):

- *Parcel E Remedial Investigation, Draft Final Report* (TtEMI, LFR, and Uribe, 1997)
- *Parcel E Information Package, Phase II Groundwater Data Gaps Investigation* (TtEMI, 2001a)
- *Revised Final Parcel E Groundwater Summary Report, Phase III Groundwater Data Gaps Investigation* (TtEMI, 2004c)

The following subsections are brief summaries of the findings from each of the documents listed above. Unless otherwise indicated, all information included in each summary was derived from the corresponding document listed above. The nature and extent of chemicals in groundwater is discussed in more detail in Section 5.

3.4.1. Remedial Investigation (1988 to 1996)

During the RI, the Navy installed monitoring wells and collected groundwater samples to determine whether hazardous substances and petroleum hydrocarbons had migrated to groundwater at Parcel E-2. Figure 3-2 shows the groundwater sampling locations, and Table 3-4 summarizes the chronology of groundwater characterization activities. In addition to groundwater sampling, the Navy installed piezometers and performed slug, step-drawdown, and constant-rate pumping tests for the purpose of aquifer characterization. Lastly, the Navy conducted a 72-hour tidal influence study within the near-shore areas of Parcel E-2. The results of the aquifer characterization and tidal influence study are discussed in Subsections 2.2.3 and 2.2.4, respectively.

The first monitoring wells in Parcel E-2 (IR01MWI-1 through IR01MW-9) were installed in 1986 as part of the confirmation study/verification step. Two of these nine wells (IR01MWI-1 and IR01MW-4; Figure 3-2) were subsequently decommissioned; however, there are no available records regarding the dates or procedures used in the decommissioning. From 1990 to 1992, the Navy performed primary and contingency sampling activities as part of the OU-I RI. Activities involved sampling existing A-aquifer monitoring wells, and installing and sampling additional A-aquifer and B-aquifer monitoring wells throughout Parcel E-2. RI activities during this period also included collecting grab-groundwater samples from soil borings to assist in the location of future monitoring wells. From 1995 to 1996, additional sampling was performed at existing monitoring wells, and several additional monitoring wells were installed to better define the groundwater conditions in the East Adjacent Area and evaluate groundwater flow patterns west and northwest of Parcel E-2 (in non-Navy property).

The RI activities produced sufficient data to identify areas of potential groundwater contamination and assess their migration potential. Following evaluation of the RI results, it was determined that additional data collection from existing monitoring wells was needed to assess current groundwater flow patterns and chemical conditions. The Navy and regulatory agencies decided to conduct a multi-phase groundwater data gaps investigation at Parcels C, D, E, and E-2.

3.4.2. Groundwater Data Gaps Investigations (2000 to 2002)

The GDGI was conducted in three phases between 2000 and 2002 to update previous assessments of groundwater conditions at HPS, supplement information gathered during the Parcel E RI, and better define the extent of groundwater contamination at HPS. The Phase I GDGI involved water level data collection at Parcels C, D, E, and E-2, and groundwater sampling at Parcels C and D. The groundwater sampling program was expanded in the Phase II and Phase III GDGI to include Parcels E and E-2. An evaluation of the condition of the monitoring wells throughout HPS was conducted during Phase II (January through April 2001), and subsequent repairs and new well installation was conducted during Phase III (February through October 2002). Three new A-aquifer wells (IR01MW-10 through IR01MW-12A) and one piezometer (IR01P-04A) were installed at Parcel E-2 to replace wells that were decommissioned during construction of the landfill gas control system and to monitor groundwater conditions in the vicinity of the landfill gas barrier wall.

The most prevalent chemicals whose concentrations exceeded GDGI evaluation criteria in Parcel E-2 were VOCs, ammonia, and cyanide. Of the VOCs detected, benzene and 1,4-dichlorobenzene were detected over a relatively extensive area at concentrations just above the maximum contaminant level (MCLs). Although other metals, SVOCs, PCBs, and pesticides were detected in concentrations exceeding GDGI evaluation criteria, the extent of these chemicals in groundwater was not widespread. The Phase III GDGI also sampled for radionuclides in Parcel E-2 groundwater; the findings of this portion of the GDGI are discussed in Subsection 3.6. The GDGI concluded that groundwater characterization at the Parcel E-2 Landfill is incomplete, and recommended that additional groundwater sampling be completed. Following evaluation of the GDGI results, the Navy and regulatory agencies decided to implement a basewide groundwater monitoring program to regularly monitor groundwater conditions at HPS. The Parcel E-2 monitoring program was designed to comply with 27 CCR requirements and is discussed in Subsection 3.9.

3.5. ECOLOGICAL ASSESSMENTS

Several ecological assessments were previously performed at Parcels E and E-2. These assessments have evaluated exposures to terrestrial receptors within the onshore areas of Parcels E and E-2 and to aquatic receptors in the Bay. The evaluation of aquatic receptors is being performed in conjunction with the CERCLA process at Parcel F. The results of previous ecological assessments are summarized in the following documents:

- *Intertidal Sediment Study and Environmental Sampling and Analyses Plan* (Aqua Terra Technologies [ATT], 1991)
- *Phase 1A ERA* (PRC, 1994) *and Phase 1B ERA* (PRC, 1996c; PRC, 1996d)
- *Baseline ERA* (TtEMI, LFR, and Uribe, 1997)
- *Draft Final ERA Validation Study and Protective Soil Concentrations (PSC) Technical Memorandum* (TtEMI and LFR; 2000a and 2000b)

- *Draft Parcel F Validation Study Report* (Battelle Memorial Institute, Entrix, Inc., and Neptune and Company, 2002)
- *Final Parcel E Nonstandard Data Gaps Investigation, Wetlands Delineation and Functions and Values Assessment* (TtEMI, 2003d)
- *Parcels E and E-2 Standard Data Gaps Investigation, Data Summary Report (Revision 01)* (TtEMI, 2005c) *and Draft Parcels E and E-2 Shoreline Characterization Technical Memorandum* (Sultech, 2005)

The following subsections are brief summaries of the findings from each of the documents listed above. Unless otherwise indicated, all information included in each summary was derived from the corresponding document listed above.

3.5.1. Intertidal Sediment Studies (1991 to 1992)

In 1991 and 1992, as part of the intertidal sediment study, sediment samples were collected in the intertidal zone of HPS, including along the Parcel E-2 shoreline, to evaluate if contaminants had migrated from Parcels E and E-2 to the Bay. The Environmental Sampling and Analyses Plan (ESAP) whole sediment study was implemented in 1991 to measure concentrations of chemicals in sediments, stormwater, and Bay water near stormwater outfalls and other potential source areas within the boundaries of HPS. Mussel tissue was also collected and analyzed.

3.5.2. Phase 1A and Phase 1B ERA (1994 to 1996)

The intertidal and ESAP data were used to identify chemicals of potential concern (COPCs) in the Phase 1A ERA. The Phase 1A ERA was a qualitative analysis that developed a preliminary characterization of HPS based on existing data, biotic surveys, and contaminant migration pathways and exposure routes. Both terrestrial and aquatic environments were considered in the Phase 1A ERA. Following the Phase 1A analysis, the quantitative Phase 1B ERA was performed to delineate potential gradients of contamination from on-shore sources to off-shore sediments, and to characterize the risk to aquatic receptors. Offshore sediment samples were collected and the sediment data were reassessed as part of the Parcel F validation study.

3.5.3. Baseline ERA (1997)

During the Parcel E RI, the terrestrial COPCs identified during the Phase 1A ERA were adopted and refined for a baseline ERA. Habitat data from the Phase 1A ERA were also used with data from a resurvey of Parcels E and E-2 in February of 1997 (see Subsection 2.4). The main purpose of the baseline ERA was to evaluate whether site contaminants have adversely affected the terrestrial environment of Parcels E and E-2. The ERA process consisted of the following activities: 1) identifying COPCs and assessment receptors; 2) analyzing receptor exposure; 3) researching ecotoxicological literature to develop toxicity reference values (TRVs) for use in the risk assessment; and 4) characterizing the risk to terrestrial receptors at Parcel E IR sites.

Lead and total PCBs were identified as Category 2 COPCs, and further evaluation of these COPCs was recommended to identify whether they are likely to pose a potential risk to terrestrial vertebrates at Parcel E-2. In addition, high molecular weight (HMW) polycyclic aromatic hydrocarbons (PAHs), total chlordane, and total dichlorodiphenyltrichloroethane (DDT) were identified as Category 2 COPCs for one receptor (the American kestrel), and further evaluation of these COPCs was recommended to identify whether they are likely to pose a risk to raptors at Parcel E-2. Also, rodent and avian toxicity data were not available for several chemicals, and a recommendation was made to re-evaluate potential risk for these chemicals if toxicity data were identified in the near future. Overall, the ERA classified Parcel E-2 as a site posing uncertain risks, but not one posing significant immediate ecological risks.

3.5.4. ERA Validation Study and Protective Soil Concentration Calculation (1999)

In response to agency comments on the Parcel E ERA, the Navy conducted the validation study to address some of the uncertainties associated with dose calculations and to develop site-specific soil concentrations that would be protective of terrestrial receptors (referred to as PSCs). Twelve collocated samples of soil, plant tissue, invertebrate tissue, lizard tissue, and small mammal tissue were collected during the study (including three sample locations from the Panhandle Area of Parcel E-2). The analytical results were used to calculate exposure doses and hazard quotients (by comparing these doses to the low and high TRVs used in the ERA). The results of these evaluations were used to develop PSCs for the representative receptor species: the American kestrel, the house mouse, and the red-tailed hawk. Based on the results of the validation study, cadmium, copper, lead, nickel, selenium, and zinc were determined to be of potential risk to ecological receptors and PSCs were derived for these chemicals. Figure 3-3 shows the soil and tissue sampling locations from the ERA Validation Study.

3.5.5. Parcel F Validation Study (2000 to 2002)

The Parcel F validation study was conducted to more accurately define the offshore areas that required evaluation in an FS. One collocated sediment and tissue sample was collected from within the Parcel E-2 shoreline (Figure 3-3). The validation study identified copper, lead, and PCBs as the primary ecological risk drivers in South Basin (the offshore area from Parcels E and E-2). The validation study hypothesized that metals and PCBs along the shoreline were a source of contamination to Parcel F sediments. Due to these results, the Navy decided to evaluate the shoreline as a potential source of copper, lead, and PCBs to Parcel F.

3.5.6. Wetlands Delineation and Functions and Values Assessment (2002)

As discussed in Subsection 2.4, the wetlands delineation identified two wetland areas within Parcel E-2: 1) approximately 3.2 acres of tidal wetlands along the shoreline south of the landfill; and 2) approximately 1.3 acres of inland seasonal freshwater wetland in the Panhandle Area (Figure 1-4). The function and values assessment determined that the wetland areas have a low ability to retain sediments and toxicants and to produce nutrients. In general, the most significant function of these wetlands is seasonal use for wintering and migrating birds. The value of these wetlands was determined to be low

because they are situated within a known hazardous waste site on manmade land. The wetlands delineation and functions and values report is discussed in more detail in Subsection 2.4, and is included as Appendix D to this report.

3.5.7. Standard Data Gaps Investigation (2002) and Shoreline Characterization Technical Memorandum (2005)

The shoreline investigation, performed as part of the SDGI, involved the collection of additional data from the intertidal sediment to evaluate whether contamination in the Parcels E and E-2 shoreline had migrated, or had the potential to migrate, to sediments in adjacent Parcel F (offshore), and to identify areas within the shoreline that posed an unacceptable ecological risk. Systematic sediment samples were collected every 100 feet at two depths (0 and 2 feet bgs) from the shoreline to identify potential sources to Parcel F. All systematic samples were analyzed for copper, lead, and PCBs. In addition, biased shoreline sediment samples were collected in suspected source areas to define the extent of known hot spots within close proximity to the Parcel E-2 shoreline (the Landfill Area and an area containing sandblast waste within the East Adjacent Area). All biased sediment samples and 10 percent of the systematic samples were analyzed for metals, hexavalent chromium, pesticides, PCBs, and SVOCs. Figure 3-3 shows the sediment sampling locations from the SDGI.

Copper and lead in shoreline sediments, adjacent to the Landfill Area and the East Adjacent Area, were determined to be a potential source of contamination to Parcel F. PCBs in shoreline sediments, adjacent to the Landfill Area, were determined to be a potential source of contamination to Parcel F. Groundwater discharge was determined to be a potential pathway for migration of metals and PCBs to Parcel F. However, due to the limited solubility of metals and PCBs in site groundwater, it is unlikely to contribute to contamination in offshore sediments. The nature and extent of chemicals in shoreline sediment is discussed in more detail in the Shoreline Characterization Technical Memorandum (Appendix G). A SLERA for the shoreline sediment is also included in Appendix G.

Soil data collected during the onshore portion of the SDGI was also evaluated to validate the COPC list used in the previous baseline ERA for terrestrial receptors. Surface soil (less than 3 feet bgs) concentrations previously used in calculating PSCs, referred to as “pre-2000 data,” were compared with surface soil concentrations representative of current soil in Parcel E-2, referred to as “all” data. Based on a comparison of these two data sets, additional chemicals were identified as COPCs. PSCs were calculated for these additional COPCs using the methodology established during the ERA Validation Study. A SLERA for the Parcel E-2 onshore area was performed to evaluate the new PSCs (along with the existing PSCs, which did not change) against the updated surface soil data set. The results of the SLERA are discussed in Section 7 and presented in Appendix L.

3.6. RADIOLOGICAL ASSESSMENTS

As discussed in Subsection 1.4.2, the HRA presented a comprehensive history of radiological operations conducted by the Navy and Navy contractors at HPS. The overall conclusion of the HRA is that low

levels of radioactive contamination exist within the confines of HPS. The HRA identified numerous locations within Parcel E-2 as "radiologically impacted," including IR-01/21 (which constitutes the majority of Parcel E-2), the ship shielding area at the southwest corner of Parcel E-2, and the Parcel E-2 shoreline (NAVSEA, 2004).

Numerous investigations of potential radiological contamination have been performed throughout HPS, including Parcel E-2. Radiological investigations performed at Parcel E-2 include:

- *Site Reconnaissance (1988 to 1989)*
- *Phase I Radiological Investigation (1991)*
- *Phase II Radiological Investigation (1993)*
- *Interim Parcel E Radiation Risk Assessment (1997)*
- *Interim Investigation between Phase IV and Phase V Radiological Investigations (2001)*
- *Phase V Radiological Investigation (2002 to 2005)*
- *Radiological Groundwater Investigation* (TtEMI, 2004c)

A brief summary of radiological investigations performed at Parcel E-2 is provided in the following paragraphs. For each investigation, the methods used to evaluate the radionuclides of concern and associated release limits were current at the time of the survey. Unless otherwise indicated, the information presented in each subsection is derived from the HRA (NAVSEA, 2004).

3.6.1. Site Reconnaissance (1988 to 1989)

In 1988, HLA conducted a preliminary surface radiation survey to determine if radioactivity levels at HPS posed unacceptable exposure risks to RI field workers. Project activities included a scintillation survey for radiation at surface locations at Parcel E-2. The Parcel E-2 Landfill surface gamma survey was conducted at grid points over the entire landfill. The average gamma count rate was determined to be significantly below the mean of the background values measured at HPS. Surface gamma counts at one location in the landfill exceeded the average level at the landfill, but were close to the mean of the HPS background values (HLA, 1990a).

3.6.2. Phase I Radiological Investigation (1991)

In 1991, the Navy began radiation investigations at HPS in four main phases as part of the RI program. Phases I and II involved field investigations at several HPS locations including Parcel E-2, while Phases III and IV were performed elsewhere at HPS (outside of Parcel E-2). Also during this period, an interim radiation risk assessment and a shoreline characterization survey were performed at Parcels E and E-2.

The portion of the Phase I radiological investigation at Parcel E-2 was conducted in two stages: 1) air monitoring; and 2) the surface confirmation radiation survey (SCRS). Phase I particulate air monitoring was conducted in 1991 to determine the background airborne particulate alpha and beta radioactivity levels at several locations, including Parcel E-2. The gross alpha and gross beta airborne particulate

concentrations were well within safety standards for airborne concentrations of general radioactive materials in outdoor air (PRC, 1992a).

The Phase I SCRS was initiated in 1992 to determine and confirm the nature and surficial extent of radium-bearing devices in several disposal areas at HPS, including Parcel E-2. During the surface walkover survey in IR-01/21, nine radioactive point source anomalies associated with radium-containing devices were observed in the southwestern and northeastern areas. Based on the results of the Phase I SCRS, a recommendation was made for further investigation.

3.6.3. Phase II Radiological Investigation (1993)

The Phase II radiological investigation was conducted in 1993, in an attempt to delineate the subsurface distribution of radium-containing devices at several locations, including Parcel E-2 (PRC, 1996a). Six 15-foot long test pits were excavated in IR-01/21. No elevated gamma count rates were measured in the test pits or trenches installed within IR-01/21; however, test pits and trenches installed at IR-02, in close proximity to Parcel E-2, contained gamma-emitting anomalies associated with radium-containing devices and firebrick.

3.6.4. Interim Parcel E Radiation Risk Assessment (1997)

As part of the Parcel E RI, TtEMI performed a radiation risk assessment to evaluate potential risks associated with human exposure (for residential and industrial scenarios) to radionuclides detected in what is now Parcels E and E-2. Radium-226 and its radioactive daughter products (lead-210 and radon-222) were identified as radionuclides of potential concern. Risks were quantified for exposure to radium-226 in soil and to radon-222 in indoor air because there is only risk to radon-222 if buildings are constructed in a radiologically contaminated area. As discussed in Subsection 1.8, the planned reuse for Parcel E-2 is open space. Therefore, an industrial exposure scenario was considered a more conservative risk assessment that likely over-estimated the risk to future site occupants. For exposure to radium-226 in the industrial exposure scenario, several exposure areas identified in the risk assessment had calculated Excess Lifetime Cancer Risks (ELCRs) between 1×10^{-6} and 1×10^{-5} for the reasonable maximum exposure (RME) case. Risks to radon-222 were not considered relevant for the Parcel E-2 area as no buildings have been constructed. The assessment report concluded that health risks for exposure to radium-226 in soil were not considered significant.

3.6.5. Interim Investigation between Phase IV and Phase V Radiological Investigations (2001)

A Characterization Survey of the shoreline of what is now Parcels E and E-2 was performed in 2001. Gamma scans were conducted over pre-positioned grids within approximately 50 feet of the mean tide line. Several areas were noted during the survey that exceeded background gamma radiation levels, most significantly the area known as the “metal reef” within Parcel E. Samples obtained from those locations identified radium-226 as the contaminant.

3.6.6. Phase V Radiological Investigation (2002 to 2003)

The Phase V radiological investigation began in January 2002 prior to issuance of the HRA. The purpose was to support of the release of buildings or areas that had been identified as areas where radioactive materials had been used or areas where remedial actions to remove known contamination had occurred. An investigation of the radiologically impacted sites in what is now Parcel E-2 was performed in 2002 and 2003. Several areas with elevated levels of radioactivity were reported. The HRA recommended further characterization, followed by remediation and a final status survey. The remedial alternatives evaluated in this report will address provisions for the proper screening, handling, and disposal of radioactive materials in Parcel E-2.

3.6.7. Radionuclide in Groundwater Evaluation (2002)

The radiological groundwater investigation for the Phase III GDGI at HPS was conducted to assess the levels of specific radionuclides in site groundwater. The general approach in designing the radiological investigation for groundwater in Parcels E and E-2 was to collect isotope-specific data for "radionuclides of interest," defined as species that may be site related or may be present in the environment as natural or anthropogenic background as known at the time (prior to issuance of the HRA). Radium-226 and radium-228 were considered primary radionuclides of potential concern at Parcel E-2 because debris disposed of at the landfill may have contained radium dials; however, groundwater samples collected from monitoring wells in the Landfill Area were analyzed for 47 specific isotopes. The analytical data were evaluated by simple (nonstatistical) threshold comparisons to a fixed standard and by statistical tests comparing the site data to background data (two-sample statistical tests), and to fixed standards (one-sample statistical tests) (TtEMI, 2004c). The statistical test results for the Landfill Area are summarized as follows:

- Statistical testing comparing groundwater data from the Landfill Area for radionuclides with drinking water or other standards (one-sample t-test) showed that no standards were statistically exceeded at the 95 percent confidence level (Appendix A, Table I-9 of Parcel E Groundwater Summary Report).
- Statistical testing comparing groundwater data from the Landfill Area and background areas (parametric and nonparametric two-sample tests) indicated that differences between background and site data sets for potassium-40, radium-226, and strontium-90 are statistically significant in at least one of the tests (Appendix A, Tables I-14 and I-15 of Parcel E Groundwater Summary Report).
- The site mean activities of 0.472 picoCuries per liter (pCi/L) for radium-226 and 0.879 pCi/L for radium-228 are far below the drinking water standard of 5 pCi/L for the sum of radium-226 plus radium-228.
- Beta emissions from naturally occurring potassium-40 exceeded the screening standard of 50 pCi/L for gross beta activity (all beta-emitting isotopes, combined). Potassium-40 occurs naturally in seawater at about 300 pCi/L, as beta emissions. Bay water samples collected for this investigation produced an average of 280 pCi/L for potassium-40.

- Other radionuclides that were detected infrequently in groundwater samples from the Landfill Area did not exceed background levels. These include two results for actinium-228 (a naturally occurring radioisotope) near the detection limit, one qualified result at the detection limit for americium-241 (alpha scan result), one result for lead-214 (naturally occurring) near the detection limit, four detections of uranium-234, and three detections of uranium-238.

The investigation concluded that naturally occurring potassium-40 in seawater is the main contributor to beta emissions measured in groundwater samples from near shore monitoring wells. The gross beta values historically reported for samples collected from near shore wells were dominated by beta emissions from natural potassium-40 in seawater, not beta emissions from radium isotopes. Background seawater contains the highest average activity of potassium-40 (280 pCi/L, beta) of all data groups, followed by near shore IR sites where saltwater intrusion has resulted in brackish groundwater conditions. This intrusion has altered the composition of near shore groundwater, with corresponding changes in the radiological quality (especially gross beta emissions). The results of the radiological groundwater investigation are detailed in the Parcel E Groundwater Summary Report (TtEMI, 2004c).

3.7. OUTDOOR AIR MONITORING

Previous outdoor air monitoring activities performed at Parcel E-2 are summarized in the following documents:

- *Final Draft Solid Waste Air Quality Assessment Test* (HLA, 1989)
- *Facility-Wide Ambient Air Monitoring* (TtEMI, LFR, and Uribe, 1997)
- *Perimeter Air Monitoring Program, Final Removal Action Landfill Cap Closeout Report* (TtEMI, 2005b)
- *Final Parcel E Nonstandard Data Gaps Investigation, Landfill Gas Characterization* (TtEMI, 2003e)

The following subsections are brief summaries of the findings from each of the documents listed above. Unless otherwise indicated, all information included in each summary was derived from the corresponding document listed above.

3.7.1. Solid Waste Air Quality Assessment Test (1988 to 1989)

Between October 1988 and February 1989, a Solid Waste Air Quality Assessment Test (SWAQAT) was conducted at several IR sites, including IR-01. The SWAQAT included evaluation of meteorological conditions, outdoor air quality, landfill gas compositions, surface gas emissions, and subsurface gas migration. The analysis of gases covered a wide range of organic compounds, including VOCs and methane. Surface gas emissions were not detected in this investigation. The only compounds detected were in the outdoor air and detected upwind from possible sources off site in the surrounding industrial areas. Methane was detected in isolated pockets at IR-01 and at the northern edge of the IR-01 boundary (near the UCSF compound but within the solid waste footprint).

3.7.2. Outdoor Air Monitoring (1992 to 1996)

As part of the RI program, the Navy performed basewide outdoor air monitoring in three phases. The first phase was conducted in 1992 at IR Sites 1 through 11, and included two upwind and one downwind sampling location. The samples were analyzed for asbestos, metals, VOCs, SVOCs, pesticides, PCBs, and formaldehyde. The detected constituents showed the highest values of asbestos and pesticides upwind, originating from the industrial areas around HPS. Low levels of VOCs were found at all locations; the highest VOC concentrations were detected at an active industrial area within Parcel D (IR-09).

A second phase of sampling was conducted in 1994. Phase II involved sample collection from 17 locations throughout HPS, including one location in Parcel E-2. The samples were analyzed for asbestos, metals, VOCs, SVOCs, pesticides, PCBs, and formaldehyde. The general conclusion of the Phase II sampling was that air contaminant concentrations at HPS are similar to the Bay Area regional air quality monitoring results, with only minor differences observed for most analytes investigated. During the Phase II sampling, a sandblast waste pile was sorted and removed in the East Adjacent Area of Parcel E-2 (Battelle, 1996). Results of the sampling showed that sites in close proximity to this sandblast waste pile had elevated levels of asbestos, metals, and PCBs (specifically Aroclor-1260), and that these elevated concentrations were related to this removal. In addition, elevated VOC concentrations at Parcel E-2 may have been influenced by a light industrial park located west of Parcel E-2 (upwind of the Phase II monitoring location). As a result, additional sampling was recommended to verify that the elevated concentrations were from off-site sources.

The Phase III outdoor air sampling was conducted in 1996, and focused on four locations from Phase II, including the one Parcel E-2 location. Two upwind sampling locations were established along the western boundary of Parcel E-2. The samples were analyzed for asbestos, metals, VOCs, and PCBs. Concentrations of asbestos, metals, and VOCs detected in the Phase III sampling were similar to regional background concentrations, and concentrations of PCBs were two orders of magnitude lower than concentrations detected in Phase II. These findings supported the conclusion that the removal of the sandblast waste pile in 1994 most likely contributed to the elevated concentrations of asbestos, metals, and PCBs detected during Phase II. In addition, the elevated VOC concentrations measured near IR-01/21 in the Phase II sampling were not detected during the Phase III investigation. The Phase II and III air monitoring locations in and adjacent to Parcel E-2 are shown in Figure 3-4.

3.7.3. Perimeter Air Monitoring Program, Landfill Cap Construction (2000 to 2001)

A grass fire burned on Parcel E-2 on August 16, 2000. After the surface fire was extinguished, subsurface smoldering was discovered. An initial 24-hour outdoor air sample was collected downwind of the fire area on August 31, 2000, and an air-monitoring network was established around the perimeter of Parcel E-2 on September 8, 2000. Air samples were collected at seven stations to determine if

contaminants were migrating toward residential and commercial receptors. The perimeter air monitoring program (PAMP) air monitoring locations in and adjacent to Parcel E-2 are shown in Figure 3-4.

The PAMP continued from September 8, 2000 until the cap was structurally completed on March 13, 2001. The objective of the PAMP at Parcel E was to identify any conditions requiring corrective measures necessary to assure that public health and the environment of the nearby community were not compromised by air emissions from the subsurface smoldering and landfill capping activities.

Integrated air sampling was conducted for VOCs, SVOCs, pesticides, PCBs, metals, low-resolution and high-resolution dioxins/furans, chlorine compounds, and phosgene. A radioactivity sample was taken during a single sample period. During the PAMP, over 2,400 different analyses were conducted on the more than 1,700 samples collected from the seven-station monitoring network. Action levels for target analytes were based on a combination of existing Action Levels established during the Parcel B soil remedial action and EPA Region IX Preliminary Remediation Goals (PRGs).

The PAMP concluded that the PCB compound, Aroclor-1260, was the primary chemical detection that was directly attributable to landfill capping activities. Almost all of the Aroclor-1260 detections were at monitoring Station F, which was in the southeast corner of Parcel E-2 (near the PCB Hot Spot that was remediated in 2005 and 2006). Detections of Aroclor-1260 were attributed to construction activities that disturbed surface soil in the area. Construction activities in the area were modified to minimize dust generation in the area. Similar precautions are being implemented during the ongoing removal action in the area, and perimeter air monitoring is also being performed.

Other conclusions from the PAMP included:

- Combustion products such as PAHs and dioxin/furans directly attributable to the fire were not prevalent, and were below project duration PAMP and annual PRG levels.
- Of the more than 150 target compounds or classes of compounds, 98 were not detected at any time during the PAMP. The following compounds and classes of compounds were not detected: pesticides (except for one detection of endrin below action levels), chlorine or hydrogen chloride, phosgene, low resolution dioxins/furans, benzo(a)pyrene, cadmium, and vinyl chloride.
- Detected concentrations of lead, nickel, and high-resolution dioxins/furans were below the corresponding PAMP and PRG action levels.
- Benzene and carbon tetrachloride were frequently detected, and observed concentrations exceeded project duration PAMP or PRG action levels. These levels were attributed to outdoor air background levels because the project average benzene and carbon tetrachloride concentrations were less than the corresponding background concentrations reported for the Bay Area Air Quality Management District outdoor air monitoring station on Arkansas Street in San Francisco.
- Bis(2-ethylhexyl)phthalate was frequently detected, and observed concentrations exceeded project duration PAMP action levels. However, PRG action levels were not exceeded. This compound is ubiquitous in nature, and is associated with PVC plastic, including gloves.

- Arsenic and manganese were frequently detected, and observed concentrations exceeded project duration PAMP or PRG action levels or 24-hour PAMP action levels. These metals are naturally occurring in soil, and observed concentrations of these metals correlated with earth-moving activities during cap construction and wind direction.

The PAMP results are presented in Attachment A of the Final Removal Action Landfill Cap Closeout Report (TtEMI, 2005b) (Appendix E). Information on the construction of the interim landfill cap is presented in Subsection 3.8.

3.7.4. Landfill Gas Characterization (2002)

As part of the NDGI, outdoor air and building atmosphere surveys were conducted to assess whether methane was present in outdoor air within 300 feet of the Parcel E-2 Landfill and in buildings or subterranean structures at concentrations exceeding 1.25 percent volume in air. The results of the outdoor air survey indicated that landfill gas was not present in the breathing zone or in building atmospheres within the landfill, within 300 feet of the landfill limit, or within surveyed, accessible buildings outside the 300-foot perimeter. The NDGI outdoor air monitoring locations in and adjacent to Parcel E-2 are shown in Figure 3-4. A more detailed discussion of outdoor air monitoring performed during the landfill gas characterization study is presented in Subsection 4.2.3.1.

3.8. PREVIOUS REMOVAL ACTIONS

Several CERCLA removal actions and other interim actions have been performed at Parcel E-2. The following is a list of the documents that summarize the results of those removal actions.

- *Field Demonstration and Technology Transfer Report on Sandblasting Grit Recycling Project* (Battelle, 1996)
- *Field Summary Report, Storm Drain Sediment Removal Action* (IT, 1997)
- *Post Construction Report, Site IR-01/21 Industrial Landfill Removal Action (Groundwater Extraction System and Containment Barrier)* (IT, 1999)
- *Removal Action Landfill Cap Closeout Report* (TtEMI, 2005b)
- *Landfill Gas Time Critical Removal Action Closeout Report* (TtEMI, 2004a)
- *Post-Construction Report, Decontaminate Process Equipment, Conduct Waste Consolidation and Provide Asbestos Services in Parcels B, C, D, and E* (TtFW, 2004c)

The following subsections are brief summaries of the findings from each of the documents listed above. Unless otherwise indicated, all information included in each summary was derived from the corresponding document listed above.

3.8.1. Sandblast Waste Fixation (1991 to 1995)

Sandblast operations that generated sandblast waste containing paint chips, heavy metals, and oil were conducted at numerous locations at HPS. A field treatment demonstration was planned to determine if the sandblast waste could be stabilized and recycled into asphalt (Battelle, 1989). Between 1991

and 1995, 4,665 tons of sandblast waste was collected and consolidated in Parcel E-2 (Figure 3-4). In addition, about 245 tons of sandblast waste was collected from eight small piles around HPS, including 2 tons from IR-11/14/15 in Parcel E. The waste was sent to an asphalt plant, where it was successfully reused in the manufacture of asphalt. This removal action was completed in 1995.

3.8.2. Storm Drain Sediment Removal Action (1996 to 1997)

From September 1996 to September 1997, the Navy removed accumulated sediments from the storm drain system at HPS to mitigate potential transport of contaminated sediments to San Francisco Bay as part of a non-time critical removal action (NTCRA). The storm drain system at HPS consists of approximately 107,000 linear feet of piping, less than 1,000 feet of which are present in Parcel E-2. Most storm drain lines within Parcel E-2 were inaccessible during the NTCRA, with the exception of a short section of storm drain (less than 200 feet) present southwest of Building 810. Activities consisted of: 1) removing sediment and debris from accessible storm drain lines, catch basins, and manholes; 2) pre- and post-cleaning video inspections of the pipelines; and 3) water jetting of the pipelines, catch basins, and manholes. Sediments generated during the cleaning of the accessible sewers were dewatered, sampled, analyzed for waste characterization purposes, and disposed of at a licensed, off-site facility.

3.8.3. Groundwater Extraction System and Containment Barrier (1997 to 1998)

Previous investigations identified high PCB concentrations in groundwater in the southeast portion of Parcel E-2. To prevent the potential transport of PCBs to the Bay, the Navy constructed a sheet-pile wall and GES to contain groundwater in this area as part of a NTCRA. The sheet-pile wall consists of 410 sheet-piles that vary in length from 12 to 55 feet. The groundwater extraction system consists of a 100-foot-long trench located inland of the sheet-pile wall, and seven 6-inch-diameter extraction wells spaced 40 to 50 feet apart. Figure 1-3 shows the location of the sheet pile wall and groundwater extraction system. The concentrations of groundwater contaminants are low enough that the extracted groundwater can be discharged into the San Francisco publicly owned treatment system without pre-treatment. Operation and maintenance of the GES are permitted through the City and County of San Francisco Industrial Wastewater Discharge Class I Permit No. 98-0301 issued on December 14, 1998, and updated on December 14, 2001. The GES was deactivated in April 2005 and remains off-line following implementation of the PCB Hot Spot removal action (TtFW, 2005a).

An evaluation of the groundwater extraction system (IT, 2001) determined that, even with the presence of the extraction system, a groundwater mound occurs between the sheet-pile wall and the Parcel E-2 Landfill during winter and spring months. During heavy rainfall events, ponding occurs at the surface in the area of the groundwater mound. The evaluation recommended that surface water management controls be taken to prevent increased recharge and the resulting groundwater mound in the area of the GES, and that more passive groundwater control measures, such as phytoremediation, be evaluated as an alternative to the current GES (IT, 2001).

3.8.4. Landfill Cap Construction (2000 to 2001)

On August 16, 2000, a brush fire burned approximately 45 percent of the landfill surface area. The surface fire was extinguished within six hours, but small subsurface areas (less than 5 acres) continued to smolder for approximately one month after the fire was extinguished (ATSDR, 2001). As part of a TCRA, an interim cap was constructed to extinguish the fire and prevent the occurrence of future fires under the capped areas. Figure 1-3 shows the area burned by the fire and the area capped during the removal action. The interim cap consists of a multilayer system of sub-base soil, HDPE membrane, synthetic drainage layer, and topsoil. Because the interim cap effectively limits air intrusion into the landfill, the effect was a smothering of any smoldering subsurface areas remaining from the fire. In addition, the interim cap significantly reduces stormwater infiltration through the landfill, thereby reducing the potential for hazardous substances to leach out from the landfill. The interim cap encompasses approximately 14.5 acres, and has been vegetated to stabilize surface soils and limit erosion. Additional information on the construction of the interim cap is provided in the Final Removal Action Landfill Cap Closeout Report (TtEMI, 2005b) (Appendix E).

3.8.5. Landfill Gas Removal Action (2002 to 2003)

Based on the findings of the landfill gas characterization, a TCRA was conducted to address explosion hazards and human health risks associated with landfill gas migration offsite. The TCRA was designed to achieve the following goals: 1) reduce concentrations of methane detected at the northern edge of the Parcel E-2 Landfill (in the subsurface under both Navy and UCSF property) to a less than the LEL of 5 percent; and 2) prevent landfill gas migration onto the nearby UCSF compound, including methane and NMOCs. To achieve these goals, the TCRA consisted of the installation and operation of a gas control, extraction, and treatment system.

The gas extraction system consists of two mobile extraction unit trailers, ten extraction wells, and five GMPs on the UCSF compound. The gas control system was installed along the northern boundary of the landfill and consists of an HDPE barrier wall, a gas collection trench sealed (on top) with bentonite, a horizontal perforated gas collection pipe, four gas vents, and a mobile active extraction unit to assist venting when necessary. Figure 1-3 shows the major components of the gas extraction and control system; a conceptual cross-section of the landfill gas control system is presented on Figure 3-5. Mobile and permanent treatment systems remove NMOCs from the vented and extracted gas.

During the TCRA, modifications to the gas extraction and control systems were implemented to improve the effectiveness of the systems. The gas control system was enhanced through installation of a grout curtain in the gas collection trench on the north side of the HDPE barrier wall, installation of a new treatment unit connected to an additional gas control system vent riser, and rehydration of the bentonite seal. Figure 1-3 shows the location of the grout curtain.

Upon completion of the TCRA, the control system was switched to a combination of passive and active operation. The passive system is currently the primary mode of landfill gas control; operating over 5 days

per week (128 hours). As a precautionary measure, the active system is operated nearly 2 days per week (40 hours) to ensure that the risk of off-site landfill gas migration is virtually eliminated. Additional information on the construction of the interim landfill gas control system is provided in the Landfill Gas Time Critical Removal Action Closeout Report (TtEMI, 2004a) (Appendix F).

3.8.6. Shoreline Cleanup (2003 to 2004)

As part of a waste consolidation effort throughout HPS, hazardous and non-hazardous debris along the Parcels E and E-2 shoreline (including portions of the Panhandle Area) was characterized and disposed off-site. The shoreline cleanup was performed from September 2003 to June 2004. Debris consisted primarily of brick, metal scrap, concrete, and wood. The debris was subsequently characterized for disposal and fell into one of two categories: non-hazardous debris or non-Resource Conservation and Recovery Act (RCRA) hazardous wood containing creosote.

The shoreline debris also included three large wooden and metal barges within the intertidal zone of Parcel E-2 and F. The barges were removed in accordance with a site-specific plan (developed to ensure compliance with the substantive aspects of the USACE Nationwide Permit Number 38) and utilized soil erosion and sediment controls to avoid or minimize adverse effects to the Bay and its aquatic life. After each barge was removed, the newly exposed areas were recontoured using hand tools. The resulting debris was consolidated with like debris for subsequent transportation and disposal or recycling.

The following materials were accumulated, characterized (as required), and disposed of as part of the Parcel E shoreline cleanup:

- Twenty-seven truckloads (containing an estimated 468 cubic yards) of non-RCRA hazardous waste debris (poles with creosote) sent to Chemical Waste Management's Kettleman Hills Landfill
- Twenty-five truckloads (containing an estimated 400 cubic yards) of non-regulated, non-hazardous debris disposed of at Waste Management's Altamont Landfill
- Eighty-one tons of metal debris sent to Circosta Metals for recycling
- A total of 344 used/waste tires were disposed of at Waste Recovery West, Livermore, California.
- Approximately 10 cubic yards of suspected ACM were collected by a qualified asbestos abatement subcontractor during the Parcel E shoreline cleanup. This material was disposed of at Chemical Waste Management's Altamont Landfill.

Because the Parcel E shoreline has been identified as an area containing radiological devices (such as, dials and deck markers with radioluminescent paint), a screening protocol was implemented to ensure that no radioactive materials were removed from the site during the Parcel E shoreline cleanup. This protocol was approved by the Navy's Radiological Affairs Support Office (RASO) prior to its implementation and involved screening suspect debris (such as metal scrap and sediment-laden debris). No radiological devices or other contamination were identified in the material collected as part of the shoreline cleanup.

3.9. ONGOING MONITORING PROGRAMS

The results of the ongoing monitoring performed at Parcel E-2 are summarized in the following documents:

- *Quarterly Groundwater Sampling Reports, Parcels C, D, and E* (Kleinfelder and CDM, 2005a through 2005c)
- *Monthly Gas Monitoring Reports* (ITSI, 2004a through 2004e and 2005a through 2005j)
- *Annual Reports for Storm Water Discharge Management* (TtEMI, 2004d; AFA Construction Group [AFA] and Eagle Environmental Construction [EEC], 2005a)
- *Annual Landfill Cap Inspection and Maintenance Program* (TtEMI, 2003b)

The following subsections are brief summaries of the monitoring programs and the current findings from each of the documents listed above. Unless otherwise indicated, all information included in each summary was derived from the corresponding documents listed above.

3.9.1. Quarterly Groundwater Monitoring (2004 to present)

In June 2004, the Navy began quarterly monitoring at Parcel E-2 under the BGMP (TtEMI, 2004e). The groundwater monitoring locations in and adjacent to Parcel E-2 are shown in Figure 3-6. A total of 21 A-aquifer wells and 10 B-aquifer wells were selected for groundwater sampling; the purpose of the sampling was to monitor chemicals that previously had been detected and to establish a baseline for other chemicals and water quality parameters that might be related to the landfill. Analyses at these landfill-area wells were selected based on 27 CCR requirements and an evaluation of previously detected chemicals. In addition, six A-aquifer wells in the Panhandle Area and one A-aquifer well in IR Site 12 (located adjacent to a former disposal trench associated with Triple A Site 4) were selected for groundwater sampling, to monitor chemicals previously detected at concentrations that may pose a potential risk to human health and the environment (TtEMI, 2004e).

Four rounds of validated groundwater monitoring data (through April 2005, when the data set was "locked" for the purposes of performing the nature and extent evaluation and risk assessments) were available for consideration in the Draft RI/FS. The quarterly monitoring data are evaluated, in conjunction with data from the RI and GDGI, in Section 5. Additional rounds of data will be incorporated into the Draft Final RI/FS; however, four wells in the monitoring network (IR01MWI-3, IR01MW43A, IR01MW44A, and IR01MW47B) were decommissioned following the April 2005 sampling event in anticipation of the PCB Hot Spot removal action. Replacement wells are anticipated to be installed in 2007.

In addition to the quarterly groundwater monitoring, groundwater flow patterns in the A-aquifer are evaluated by the development of groundwater elevation maps as part of the BGMP. A-aquifer groundwater elevation measurements are collected using a methodology designed to reduce the significance of tidal effects on the general definition of the potentiometric surface (TtEMI, 2004e).

3.9.2. Monthly Gas Monitoring and Control (2004 to present)

Landfill gas is being monitored on a monthly basis under the Interim Landfill Gas Monitoring and Control Plan (TtEMI and ITSI, 2004c) to verify that hazardous levels of landfill gas are not migrating beyond the fence line of the landfill and onto the UCSF compound. The monitoring locations include 32 GMPs, 5 passive vents, 17 groundwater wells on the landfill cap (used for gas monitoring), and outdoor air and subterranean structure locations both on Parcel E-2 and within the UCSF compound (Figure 3-7). The monthly gas monitoring reports present results of the landfill gas monitoring, the status of the gas extraction system (active operation and/or passive operation), maintenance observations on the gas control system, and meteorological data. Several subsurface utilities associated with the GES were removed in summer 2005 during implementation of the PCB Hot Spot removal action, and were not available for monitoring.

The ongoing landfill gas control program, based on the Interim Landfill Gas Monitoring and Control Plan (TtEMI and ITSI, 2004c), includes notification and response procedures in the event that hazardous levels of landfill gas are detected beyond the fence line of the landfill and beneath the UCSF compound. In monthly monitoring performed since January 2004, all concentrations of NMOCs were below action levels and regulatory requirements identified in the Interim Landfill Gas Monitoring and Control Plan. Methane concentrations have, in nearly all cases, remained below specified regulatory action levels; however, methane concentrations in excess of specified regulatory action levels have been detected in January 2004 and January 2006. In these instances, the Navy has notified the appropriate parties and implemented response measures to control landfill gas at the fence line of the landfill and at the GMPs located on the UCSF property.

3.9.3. Storm Water Discharge Management (2003 to present)

Storm water discharge in Parcel E-2 is managed in accordance with a SWDMP that was originally published in 2003 (TtEMI, 2003c). The Parcel E-2 storm water program involves quarterly non-storm water discharge visual observations, storm water sampling and analysis, monthly storm water discharge visual observations, and an annual comprehensive site compliance evaluation. Storm water monitoring locations are shown on Figure 2-21, and are discussed in more detail in Section 2.3. Figure 2-21 also depicts BMPs that are utilized at Parcel E-2 to control storm water discharges.

The results of the Parcel E-2 storm water program are summarized on an annual basis (TtEMI, 2004d; AFA and EEC, 2005a). Results to date indicate no incidents of non-compliance at Parcel E-2 except in isolated locations where BMPs require modification to better control erosion and sediment transport from neighboring properties. The SWDMP is revised on an annual basis to reflect current site conditions, clarify or change the discharge locations, and update the list of BMPs (TtEMI, 2005a; AFA and EEC, 2005b).

3.9.4. Landfill Cap Inspection and Maintenance (2003 to present)

Inspection and maintenance of the interim landfill cap is performed in accordance with a site-specific operation and maintenance (O&M) plan (TtEMI, 2003b). The O&M plan addresses and provides guidance for inspecting and reporting activities that are required to ensure the integrity of the landfill cap. In addition, the SWDMP contains requirements that facilitate and support implementation of the O&M plan. Also included in the O&M plan are emergency response procedures which are to be followed in the event of flood, major storm event, earthquake, or fire.

The operations associated with the closed landfill include 1) an irrigation system to maintain the vegetative cover and 2) mowing of the vegetative cover on and adjacent to the cap to reduce potential fire hazards and prevent the growth of large shrubs and trees whose root structure could penetrate the cap. The irrigation system, along with other components of the interim cap, is inspected on a quarterly basis to ensure that it is functioning properly and providing adequate water to the vegetative cover. Inspection and mowing of the vegetative cover is performed twice per year. Records of the inspection and maintenance activities are maintained by the Navy's Caretaker Site Office.

3.10. RECENT REMOVAL ACTIONS

Two TCRAs were performed at Parcel E-2, concurrent with the preparation of this RI/FS report. These include: 1) removal of contaminated material from the Metal Slag Area located along the shoreline of the Panhandle Area; and 2) removal of contaminated soils from the PCB Hot Spot located along the southern portion of Parcel E-2, within the Landfill and East Adjacent Areas. Figure 1-3 shows the initial and current (as of September 2006) excavation boundaries for each removal area. Although the results of these ongoing remedial activities have not yet been published, the respective project work plans describe the design and implementation methodology for each removal action and regular updates to the BCT provided information on the field conditions. The following subsections summarize these removal actions.

3.10.1. Metal Slag Area Removal Action (2005 to 2006)

The TCRA at the Metal Slag Area is being performed in conjunction with the removal of the Metal Debris Reef located in the southeast portion of Parcel E. The TCRA was designed to remove metal slag and debris containing low-level radiological material, as well as non-radiological chemical contamination incidental to the removal of the area. Site characterization was performed to delineate the vertical and horizontal extents of the metal debris and slag (as discussed in Subsection 3.3.3). A detailed description of the scope of this removal action is included in the Draft Final Removal Action Design and Implementation Work Plan, Metal Debris Reef and Metal Slag Areas (TtFW, 2005b).

As of May 2006, approximately 74 cubic yards of soil and sediment were segregated as radiologically impacted (out of a total excavated volume of 8,560 cubic yards). Also, 32 radiological devices, 15 cubic yards of radiological debris, and 9 cubic yards of fire brick were identified within the removal area

(BRAC PMO West, 2006a; BRAC PMO West, 2006b). In addition to this radiologically impacted debris, five waste drums were recovered from the removal area (BRAC PMO West, 2006b). The waste characterization data for these drums are not available for this Draft RI/FS, but this data will be provided in the removal action completion report. The excavation and backfilling at the Metal Slag Area was completed in May 2006, and wetlands mitigation activities (which are associated with the removal action) are currently being planned.

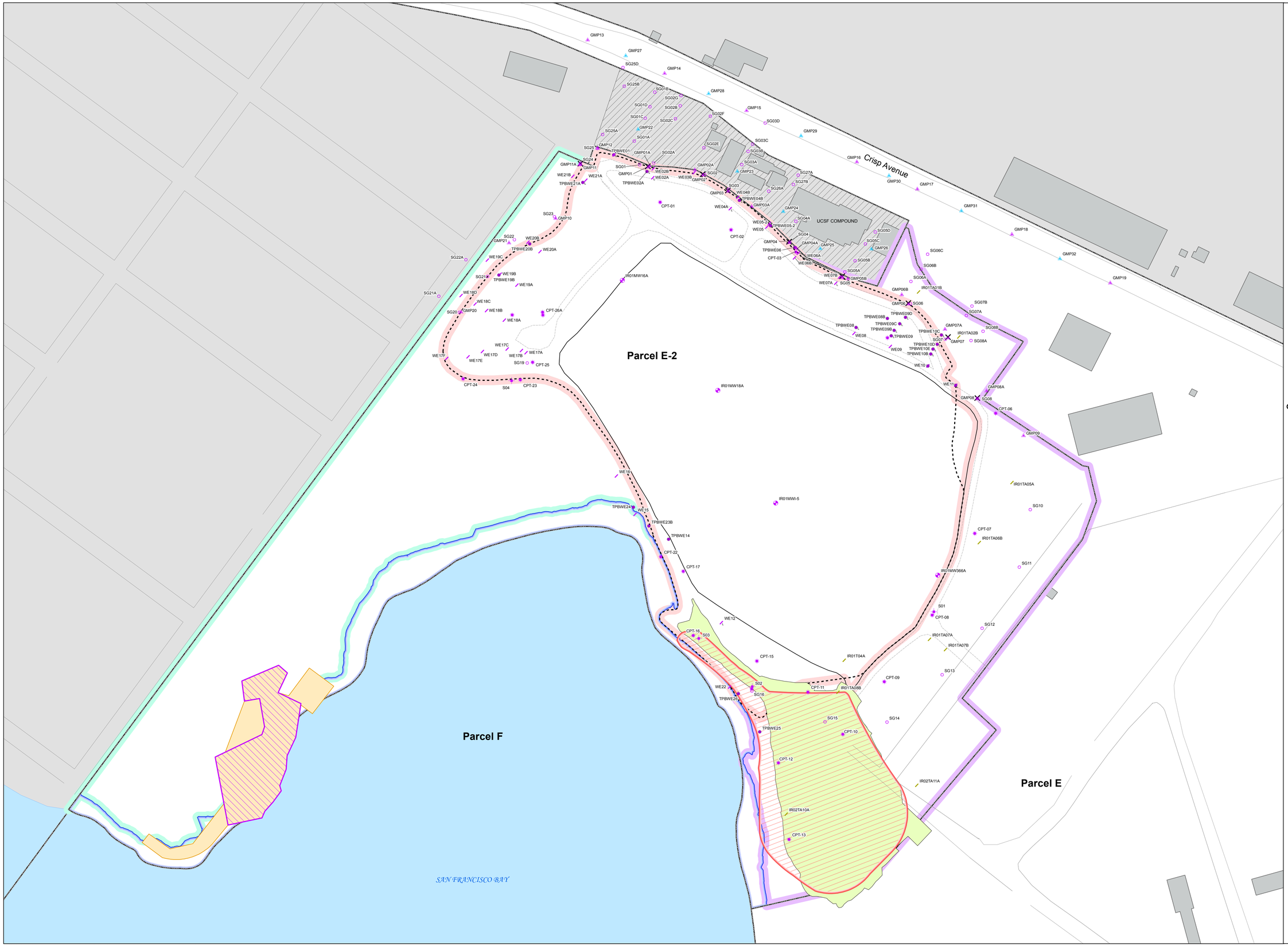
3.10.2. PCB Hot Spot Soil Excavation Site Removal Action (2005 to 2006)

The TCRA at the PCB Hot Spot was designed to remove PCB and petroleum hydrocarbon-contaminated soil and debris, possibly containing low-level radiological material. The excavation involved the removal of soils that contain PCBs at concentrations greater than the depth-based removal action goals (1 milligram per kilogram [mg/kg] from the surface to 3 feet bgs, and 100 mg/kg deeper than 3 feet bgs), TPH at concentrations greater than 3,500 mg/kg, or radioactive contaminants above the radiological removal action goals. The removal action goals also included removal of, to a practical extent, free-phase petroleum hydrocarbons. A detailed description of the scope of this removal action is included in the Project Work Plan (TtFW, 2005a).

As of September 2006, approximately 324 cubic yards of soil and sediment were segregated as radiologically impacted (out of a total excavated volume of 44,500 cubic yards). Also, 41 radiological devices and 108 cubic yards of fire brick were identified within the removal area (BRAC PMO West, 2006c). In addition to this radiologically impacted debris, 110 drums and 537 assorted waste containers were recovered from the removal area (BRAC PMO West, 2006c). The waste characterization data for these drums and containers are not available for this Draft RI/FS, but this data will be provided in the removal action completion report.

The excavation and backfilling at the PCB Hot Spot was completed in September 2006. Backfilling operations required the extraction and treatment of 3,710,000 gallons of ground and surface water that had entered the excavation. As shown in Figure 3-2, the shoreline portion of the PCB Hot Spot was not excavated. Excavation in this area was not possible because of its proximity to the Bay; however, the Navy is evaluating the possibility of excavating this area under another phase of the TCRA.

Figures



LEGEND

- A-Aquifer Monitoring Well
- CPT Boring
- Gas Monitoring Probe
- Gas Monitoring Probe (removed)
- SPT Boring
- Temporary Soil Gas Boring
- Test Pit
- Test Pit Boring (soil samples collected)
- Test Pit (lithology only)
- Test Pit Boring (lithology only)

- Basewide Groundwater Monitoring Program
- Confirmation Study
- Groundwater Data Gaps Investigation
- Groundwater Extraction System NTCRA
- Landfill Gas TCRA
- Metal Slag Area TCRA
- Non-standard Data Gaps Investigation
- Parcel F Validation Study
- ERA Validation Study
- Petroluem Program
- Remedial Investigation
- Standard Data Gaps Investigation

- Road
- Estimate of Solid Waste Extent
- Gravel Road
- Interim Landfill Cap Extent
- Parcel Boundary
- Landfill Area
- East Adjacent Area
- Panhandle Area
- Shoreline Area
- Building
- UCSF Compound
- Parcel F Boundary
- San Francisco Bay
- Non-Navy Property

Ongoing Removal Actions

- Proposed Metal Slag TCRA
- Actual Metal Slag TCRA*
- Proposed PCB Hot Spot TCRA
- Actual PCB Hot Spot TCRA*

Notes:
CPT Cone Penetrometer Test
SPT Standard Penetrometer Test
ERA Ecological Risk Assessment
NTCRA Non-Time Critical Removal Action
TCRA Time-Critical Removal Action
* Actual boundaries of removal action excavation areas as of September 2006.

N

100 0 100

Scale in Feet

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FIGURE 3-1

LANDFILL CHARACTERIZATION SAMPLING LOCATIONS

Remedial Investigation/Feasibility Study for Parcel E-2

LEGEND

- A-Aquifer Monitoring Well
- A-Aquifer Monitoring Well (with soil sample)
- A-Aquifer Piezometer
- A-Aquifer Piezometer (with product sample)
- B-Aquifer Monitoring Well
- B-Aquifer Monitoring Well (with soil sample)
- Shoreline Soil Sample
- Metal Slag Characterization Boring
- Soil Boring
- Soil Boring/Hydropunch
- Surface Soil Sample
- Test Pit
- Decommissioned - Not Sampled
- Basewide Groundwater Monitoring Program
- Confirmation Study
- Groundwater Data Gaps Investigation
- Groundwater Extraction System NTCRA
- Landfill Gas TCRA
- Metal Slag Area TCRA
- Non-standard Data Gaps Investigation
- Parcel F Validation Study
- ERA Validation Study
- Petroluem Program
- Remedial Investigation
- Standard Data Gaps Investigation
- Road
- Estimate of Solid Waste Extent
- Gravel Road
- Interim Landfill Cap Extent
- Parcel Boundary
- Landfill Area
- East Adjacent Area
- Panhandle Area
- Shoreline Area
- Building
- UCSF Compound
- Parcel F Boundary
- San Francisco Bay
- Non-Navy Property

Ongoing Removal Actions

- Proposed Metal Slag TCRA
- Actual Metal Slag TCRA*
- Proposed PCB Hot Spot TCRA
- Actual PCB Hot Spot TCRA*

Notes:
ERA Ecological Risk Assessment
NTCRA Non-Time Critical Removal Action
TCRA Time-Critical Removal Action
* Actual boundaries of removal action excavation areas as of September 2006.

Sample locations shown on this map are only for chemical analyses in soil and groundwater; see Figure 3-1 for geotechnical characterization samples in and around Parcel E-2 Landfill.

100 0 100
Scale in Feet

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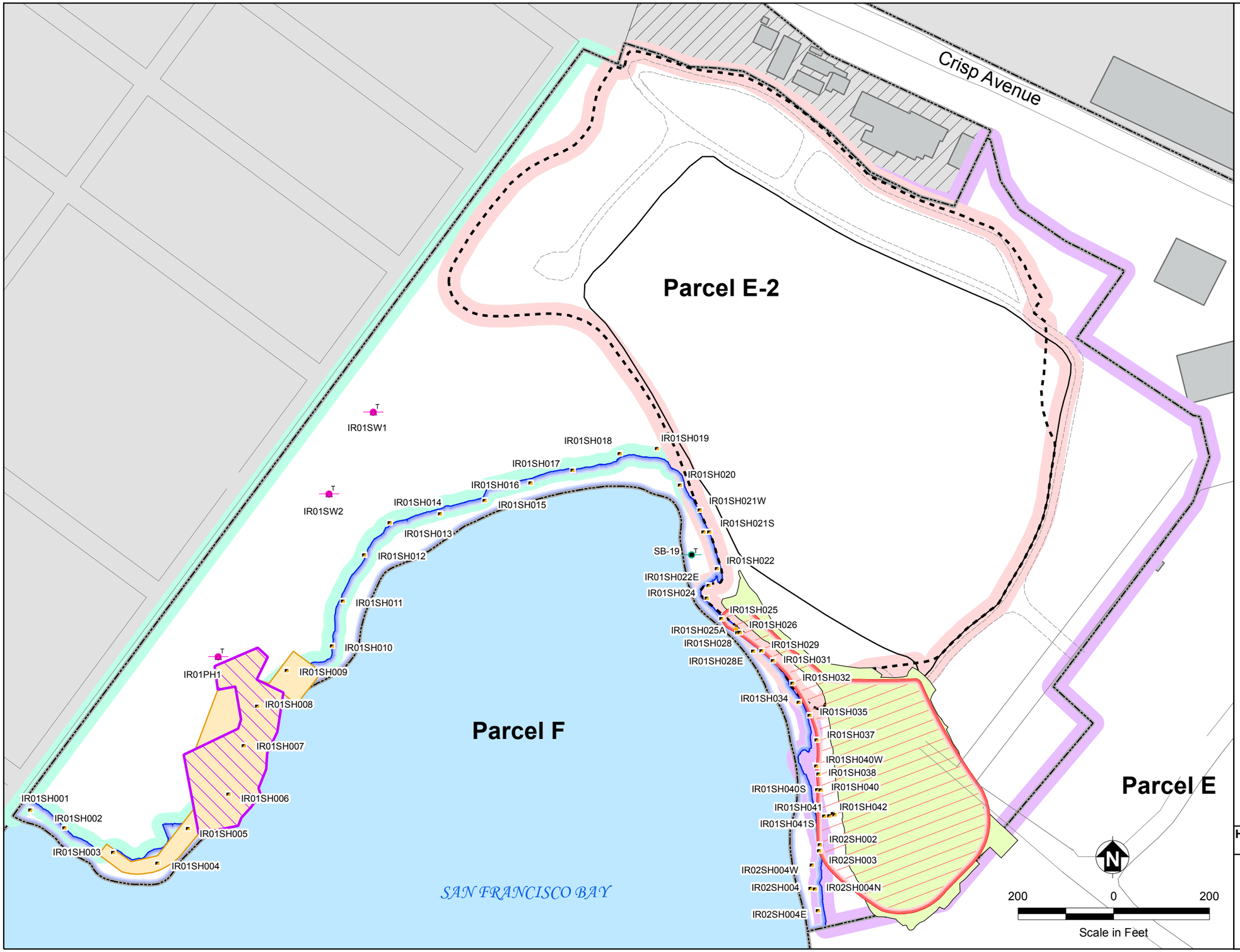
FIGURE 3-2

SOIL AND GROUNDWATER SAMPLING LOCATIONS

Remedial Investigation/Feasibility Study for Parcel E-2

2005-12-16 P:\2005_Projects\25-049_Navy_HPS_E-2_RI-FS\N_Maps&Drawings\GIS\Projects\Landfill\Landfill_RI\Section 3\Current Figures\3-2 Soil and Groundwater Sampling Locations.mxd



Legend

- Brick Sample
- Shoreline Sediment Sample
- Surface Sediment Sample (co-located with Tissue Sample)
- Surface Soil Sample (co-located with Tissue Sample)
- Tissue Sample
- ERA Validation Study
- Parcel F Validation Study
- Standard Data Gaps Investigation
- Road
- Estimate of Solid Waste Extent
- Gravel Road
- Interim Landfill Cap Extent
- Parcel Boundary
- Shoreline Area
- Landfill Area
- East Adjacent Area
- Panhandle Area
- Building
- UCSF Compound
- Parcel F Boundary
- San Francisco Bay
- Non-Navy Property

Ongoing Removal Actions

- Proposed Metal Slag TCRA
- Actual Metal Slag TCRA*
- Proposed PCB Hot Spot TCRA
- Actual PCB Hot Spot TCRA*

Notes:

ERA Ecological Risk Assessment
TCRA Time-Critical Removal Action
* Actual boundaries of removal action excavation areas as of September 2006.

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FIGURE 3-3

ECOLOGICAL SAMPLING LOCATIONS

Remedial Investigation/Feasibility Study for Parcel E-2

2005-12-16 P:\2005_Projects\25-049_Navy_HPS_E-2_RI-FS\N_Maps&Drawings\GIS\Projects\Landfill\Landfill_RI\Section 3\Current Figures\3-3 Ecological Sampling Locations.mxd

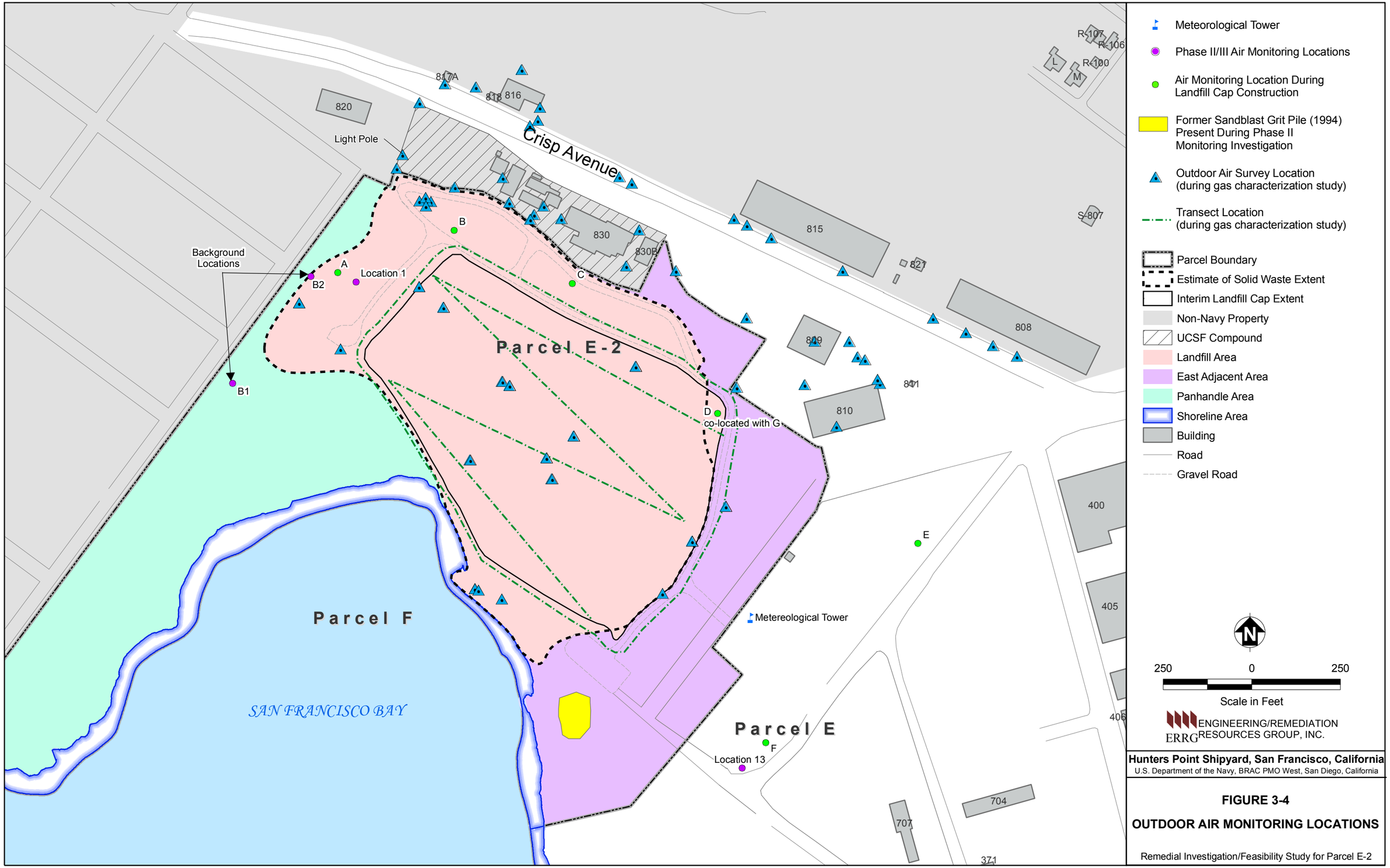

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FIGURE 3-4

OUTDOOR AIR MONITORING LOCATIONS

Remedial Investigation/Feasibility Study for Parcel E-2

2005-12-16 P:\2005_Projects\25-049_Navy_HPS_E-2_RI-FS\N_Maps&Drawings\GIS\Projects\Landfill\Landfill_RI\Section 3\Current Figures\3-4 Ambient Air Monitoring Locations.mxd

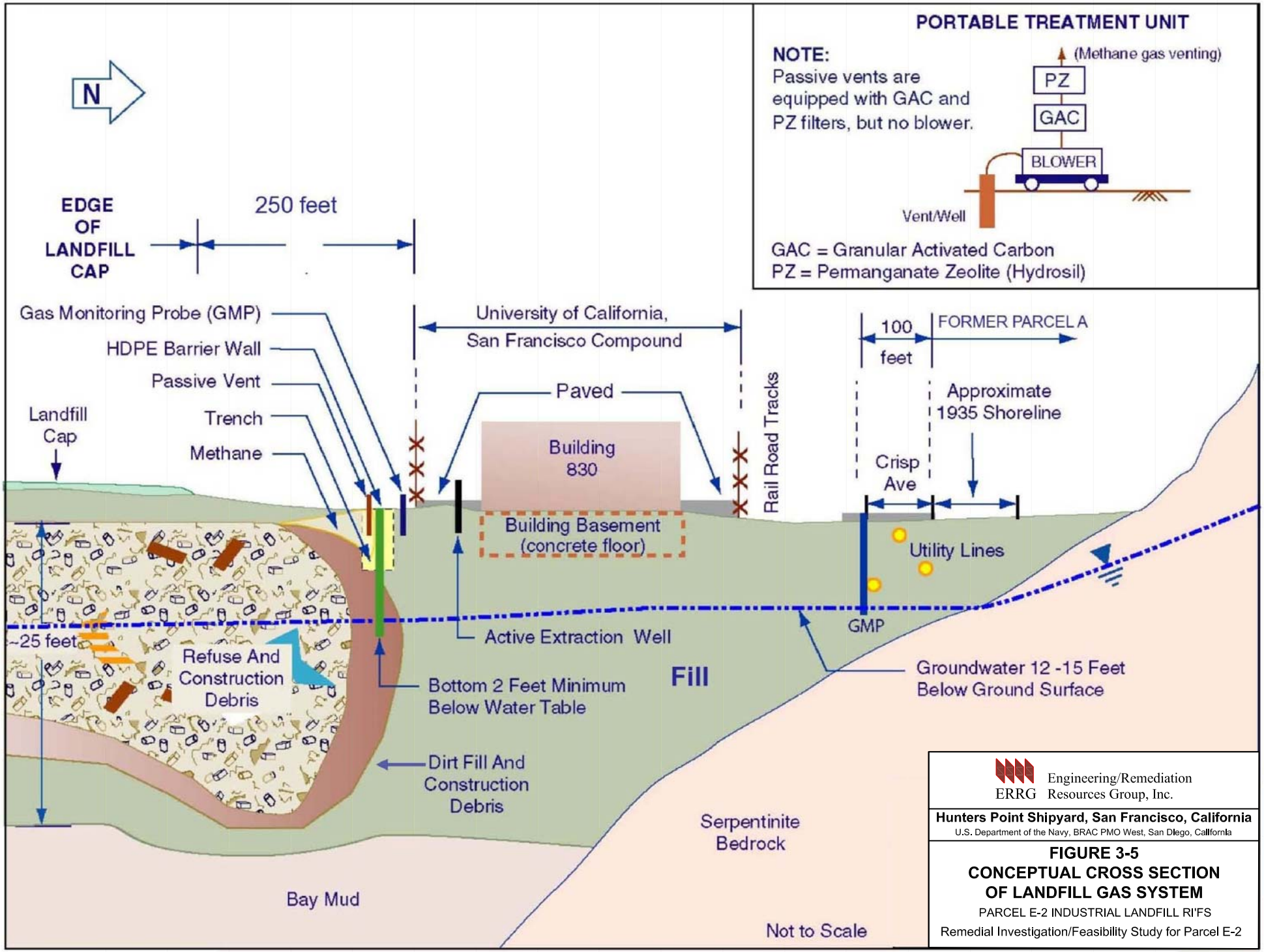

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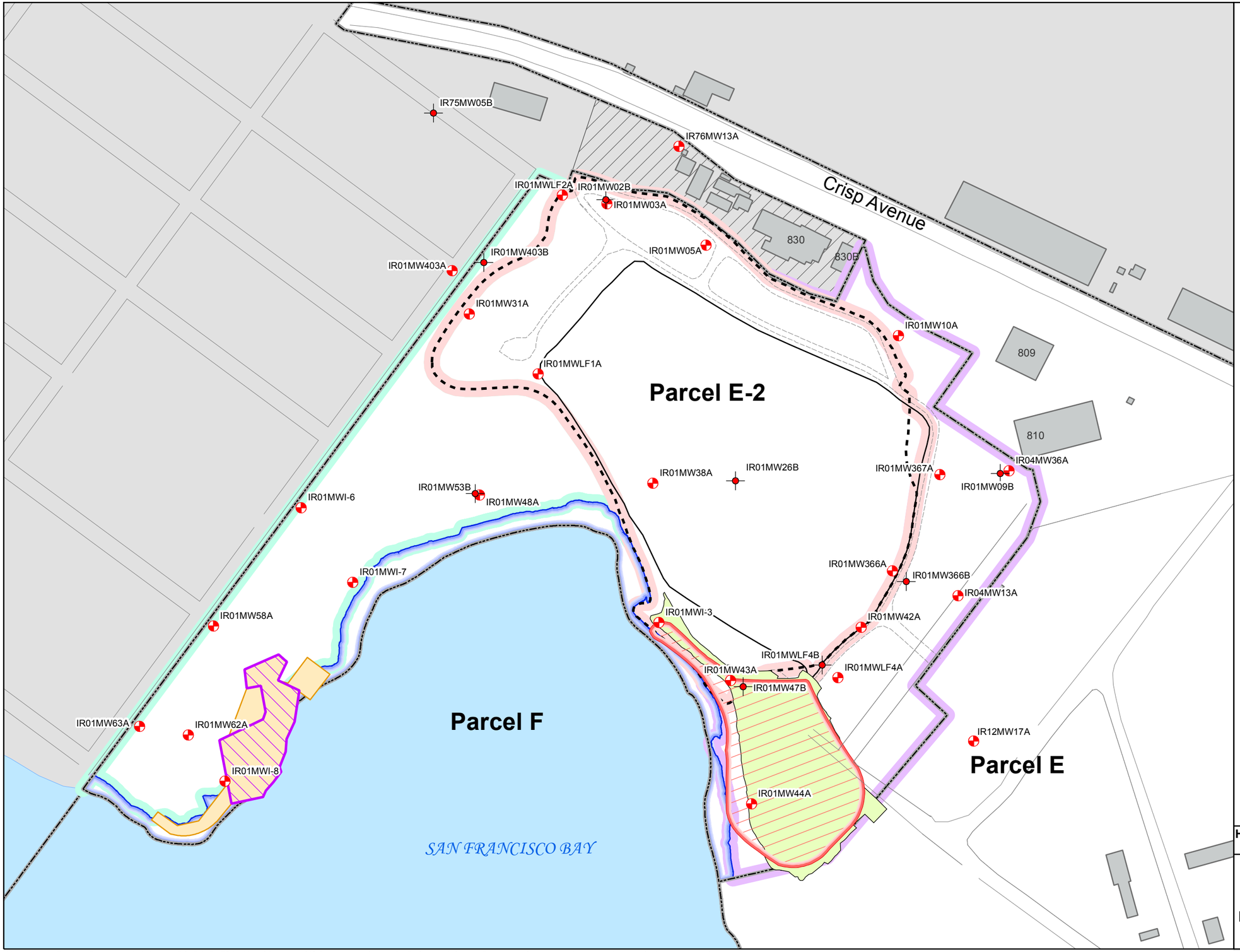
FIGURE 3-5
CONCEPTUAL CROSS SECTION OF LANDFILL GAS SYSTEM
PARCEL E-2 INDUSTRIAL LANDFILL RI'FS
Remedial Investigation/Feasibility Study for Parcel E-2

Reference: TTEMI and ITSI, 2004. Final Interim Landfill Gas Monitoring and Control Plan.



Legend

Basewide Groundwater Monitoring Program

- A-Aquifer Monitoring Well
- B-Aquifer Monitoring Well
- Road
- Estimate of Solid Waste Extent
- Gravel Road
- Interim Landfill Cap Extent
- Parcel Boundary
- Shoreline Area
- Landfill Area
- East Adjacent Area
- Panhandle Area
- Building
- UCSF Compound
- Parcel F Boundary
- San Francisco Bay
- Non-Navy Property

Ongoing Removal Actions

- Proposed Metal Slag TCRA
- Actual Metal Slag TCRA*
- Proposed PCB Hot Spot TCRA
- Actual PCB Hot Spot TCRA*

Notes:
TCRA Time-Critical Removal Action
* Actual boundaries of removal action excavation areas as of September 2006.

N

250 0 250

Scale in Feet

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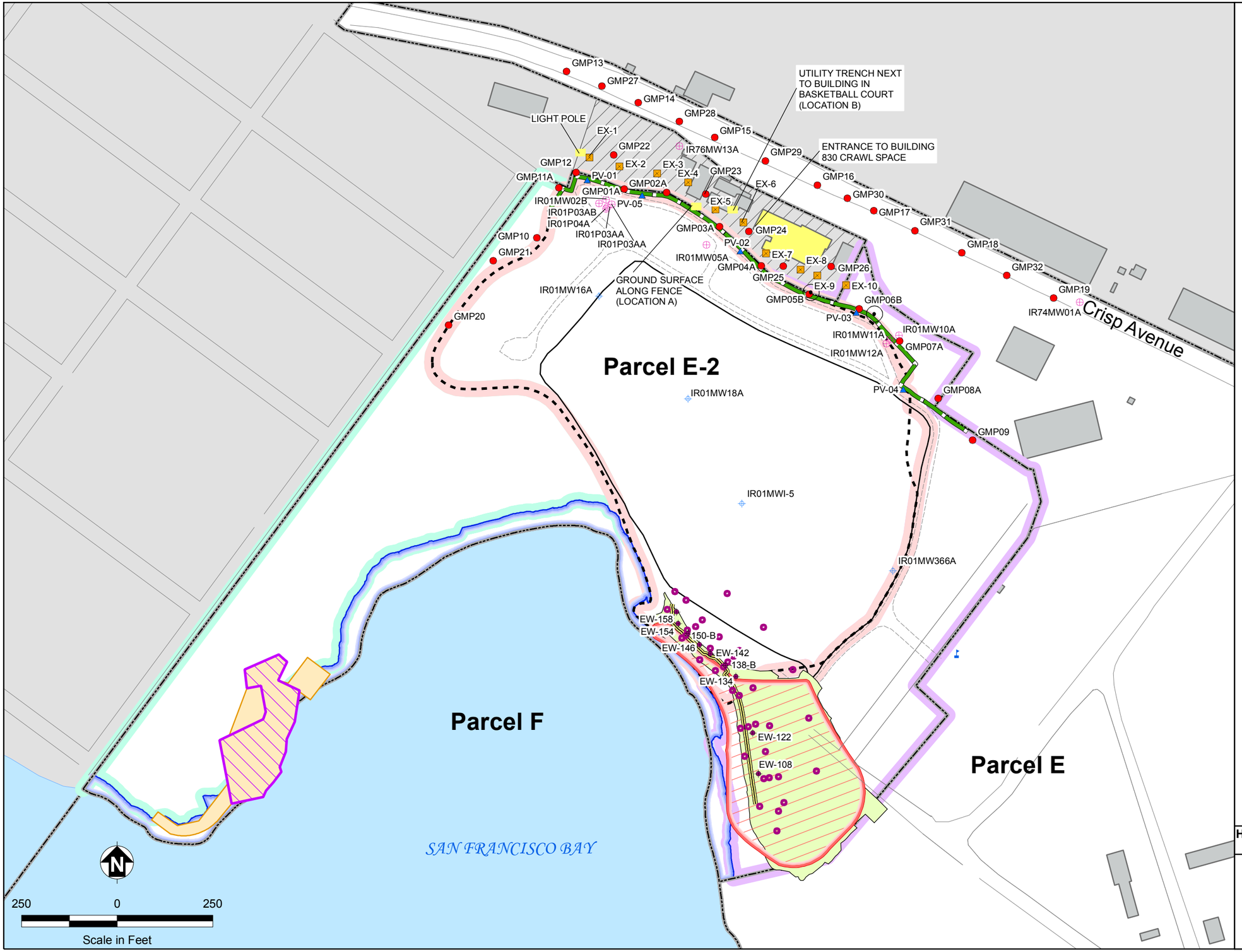
FIGURE 3-6

GROUNDWATER MONITORING NETWORK FOR PARCEL E-2 LANDFILL

Remedial Investigation/Feasibility Study for Parcel E-2

2005-12-16 P:\2005_Projects\25-049_Navy_HPS_E-2_RI-FS\N_Maps&Drawings\GIS\Projects\Landfill\Landfill_RI\Section 3\Current Figures\3-6 Groundwater Monitoring Network for Industrial Landfill Area.mxd



Legend

- Gas Monitoring Probe
- Extraction Well
- Passive Vent
- Groundwater Monitoring Well Under Landfill Gas Monitoring Program
- Groundwater Monitoring Well for Water Level Measurements
- Groundwater Extraction System Well/Vault
- Groundwater Extraction System Piezometer
- Meteorological Station
- Surface Location or Occupied Structure
- Barrier Wall
- Sheet Pile Wall
- Road
- Estimate of Solid Waste Extent
- Gravel Road
- Interim Landfill Cap Extent
- Parcel Boundary
- Shoreline Area
- Landfill Area
- East Adjacent Area
- Panhandle Area
- Building
- UCSF Compound
- Parcel F Boundary
- San Francisco Bay
- Non-Navy Property

Ongoing Removal Actions

- Proposed Metal Slag TCRA
- Actual Metal Slag TCRA*
- Proposed PCB Hot Spot TCRA
- Actual PCB Hot Spot TCRA*

Notes:
TCRA Time-Critical Removal Action
* Actual boundaries of removal action excavation areas as of September 2006.

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FIGURE 3-7

LANDFILL GAS MONITORING SYSTEM LOCATIONS

Remedial Investigation/Feasibility Study for Parcel E-2

Tables

Table 3-1 Summary of Characterization Activities, Hunters Point Shipyard Parcel E-2, Remedial Investigation/Feasibility Study

Tasks	Number of Borings, Wells, Test Pits, or Samples	Characterization			
		Landfill	Soil	Groundwater	Aquifer
Remedial Investigation					
Soil Borings [a]	66	X	X		
Test Pits	10	X	X		
Soil Samples [b]	585		X		
Groundwater Monitoring Wells [c]	34			X	
Surface Soil Samples	18		X		
Groundwater Samples [d]	187			X	
Piezometers	4				X
Oil Samples	1	X			
Data Gaps Investigations and Landfill Compliance Monitoring (through March 2005)					
Soil Borings	58		X		
Test Pits	30	X	X		
Soil Samples [e]	236		X		
Groundwater Monitoring Wells	6			X	
Surface Soil Samples	0		X		
Groundwater Samples	229			X	
Piezometers	1				X
Additional Activities					
Geophysical Survey (RI)		Ecological Assessments			
Soil Gas Surveys (RI and NDGI)		Shoreline Sediment Characterization (SDGI)			
Ambient Air Surveys (RI and NDGI)		Wetland Delineation/Assessment (RI and NDGI)			
Landfill Gas Monitoring (NDGI)		Aquifer Testing (RI)			
Liquefaction Potential Study (NDGI)		Tidal Influence Studies (RI and GDGI)			
Radiological Assessments		Stormwater Management and Monitoring			

Table 3-1 Summary of Characterization Activities, Hunters Point Shipyard Parcel E-2, Remedial Investigation/Feasibility Study (continued)

Notes:

GDGI Groundwater data gaps investigation

NDGI Non-standard data gaps investigation

RI Remedial investigation

SDGI Standard data gaps investigation

a Includes 46 soil borings and 20 monitoring well borings

b Includes 374 samples from soil borings, 175 samples from monitoring well borings, and 11 samples from test pits

c Includes 28 A-aquifer monitoring wells and 6 B-aquifer monitoring wells

d Includes 171 samples collected from monitoring wells (147 from A-aquifer monitoring wells and 24 from B-aquifer monitoring wells), 1 sample from a Hydropunch™ boring, and 15 grab-groundwater samples collected from open boreholes

e Includes 139 samples from soil borings and 55 samples from test pits, 21 from metal slag samples, and 21 from the shoreline

Table 3-2 Chronology of Landfill Characterization Activities, Hunters Point Shipyard Parcel E-2, Remedial Investigation/Feasibility Study

Investigation Phase	Date	Sample Type(s)	Sample ID(s)	General Location	Sampling Purpose
RI, Phase I, Reconnaissance Activities	October 1988	Em Transects	NA	▪ Boundaries of IR-01/21	▪ Locate boundaries and areas of differing waste composition
RI, Phase I, Reconnaissance Activities	October 1988	GPR	NA	▪ Northeast boundary of IR-01/21	▪ Delineate the northeast boundary due to inconclusive Em data
RI, Phase I, Reconnaissance Activities	October 1988	Test Pits	IR01T001, IR01T02A, IR01T02B, IR01T03A, IR01T03B, IR01T04A*, IR01T04B	▪ Presumed landfill boundaries (based on Em and GPR results)	▪ Confirm or deny the boundaries of the landfill
RI, Phase III, Contingency Sampling	March 1992	Piezometer oil sample	IR01P03A	▪ North corner of IR-01/21	▪ Identify hazardous substances potentially in groundwater
NDGI, Landfill Gas Characterization	April 2002	Temporary Soil Gas Probes	SG01 through SG27 (including step-outs)	▪ Adjacent to landfill	▪ Delineate and characterize landfill gas
NDGI, Landfill Gas Characterization	April to November 2002	Gas Monitoring Probes	GMP01 through GMP21	▪ Northern portion of IR-01/21 ▪ UCSF Compound ▪ Crisp Avenue	▪ Evaluate potential landfill gas migration ▪ Evaluate performance of landfill gas removal action ▪ Monitor landfill gas migration
NDGI, Landfill Lateral Extent Evaluation	March to April 2002	Test Pits/Test Pit Borings	WE01 through WE22 (including step-outs)	▪ Adjacent to landfill	▪ Determine the edge of the continuous physical waste in the Landfill

Table 3-2 Chronology of Landfill Characterization Activities, Hunters Point Shipyard Parcel E-2, Remedial, Investigation/Feasibility Study (Continued)

Investigation Phase	Date	Sample Type(s)	Sample ID(s)	General Location	Sampling Purpose
NDGI, Landfill Liquefaction Potential Evaluation	April 2002	CPT/SPT Borings	CPT-01 through CPT-26, S01 through S05	▪ Adjacent to landfill	▪ Determine the potential for subsurface layers, in the vicinity of the landfill, to liquefy during an earthquake

Notes:

*	Sample location within Landfill Area
CPT	cone penetrometer test
Em	electromagnetic
GMP	gas monitoring probe
GPR	ground penetrating radar
IR	Installation Restoration
NA	not applicable
NDGI	Non-standard data gaps investigation
RI	Remedial Investigation
SPT	standard penetrometer test
UCSF	University of California, San Francisco

Table 3-3 Chronology of Soil Characterization Activities, Hunters Point Shipyard Parcel E-2, Remedial Investigation/Feasibility Study

Investigation Phase	Date	Sample Type(s)	Sample ID(s)	General Location	Sampling Purpose
RI, Phase I, Reconnaissance Activities	November to December 1988	Soil Borings	IR01B001, IR01B008, IR01B025, IR01B036, IR01B046*, IR01B052	▪ Shoreline ▪ Central portion of the site ▪ North corner of IR-01/21	▪ Subsurface stratigraphy data ▪ Depth to bedrock
RI, Phase I, Reconnaissance Activities	May to June 1989	Phase I soil gas survey	100 foot grid with 92 stations	▪ Throughout IR-01/21	▪ Qualitative indication of the distribution of VOCs in soil
RI, Phase II, Primary Sampling Activities	October to November 1990	Soil Borings / Monitoring Well Borings	IR01B01A*, IR01B023*, IR01B032, IR01B34, IR01B35, IR01B039*, IR01B040*, IR01B041*, IR01B048A, IR01B049, IR01B050, IR01B055, IR01B56, IR01B060, IR01B061, IR01B064, IR01MW42A*, IR01MW48A	▪ Within and surrounding the reported landfill boundary	▪ Investigate the nature and extent of hazardous substances present
RI, Phase II, Primary Sampling Activities	December 1990	Surface Soil Samples	IR01SS082, IR01SS083, IR01SS084	▪ Western perimeter of IR-01/21	▪ Characterize nature and extent of hazardous substances in surface soil and their potential impact on air quality
RI, Phase II, Primary Sampling Activities	March to April 1991	Soil Borings / Monitoring Well Borings	IR01B003A*, IR01B004*, IR01B005A*, IR01B031A*, IR01MW02B*, IR01MW03A*, IR01MW07A, IR01MW26B*, IR01MW38A*, IR01MW43A*, IR01MW44A, IR01MW53B, IR01MW58A	▪ Northern perimeter of the site ▪ Shoreline of IR-01/21	▪ Investigate the nature and extent of hazardous substances at IR-01/21

Table 3-3 Chronology of Soil Characterization Activities, Hunters Point Shipyard Parcel E-2, Remedial Investigation/Feasibility Study (Continued)

Investigation Phase	Date	Sample Type(s)	Sample ID(s)	General Location	Sampling Purpose
RI, Phase III, Contingency Sampling Activities	June 1992	Surface Soil Samples	IR01SS351, IR01SS353, IR01SS366*	▪ Vicinities of IR01SS351, IR01SS353, IR01SS366	▪ Resample to replace unusable analytical data
RI, Supplemental Sampling Activities	October 1995	Monitoring Well Boring	IR01MW367A	▪ East margin of Parcel E-2	▪ Characterize the nature and extent of hazardous substances
RI, Supplemental Sampling Activities	November 1995	Surface Soil Samples	IR72SS18, IR72SS19, IR72SS20, IR72SS24	▪ Northeast corner of Parcel E-2	▪ Assess the content of metals in shallow soil ▪ Evaluate the hazardous substance content of shallow soils in stained areas
RI, Supplemental Sampling Activities	October 1995 to February 1996	Soil Borings	IR72B034, IR72B035, IR72B039	▪ Northeast corner of Parcel E-2	▪ Determine possible hazardous substance content of soil at a lumber and motor storage area
RI, Supplemental Sampling Activities	June 1996	Soil Boring	IR76B002	▪ Northeast corner of Parcel E-2	▪ Investigate the extent of the landfill in the vicinity of Building 830
NDGI, Landfill Lateral Extent Evaluation	March and September 2002	Test Pits	WE01, WE02B, WE03B, WE04B, WE05, WE06A, WE06B, WE07B, WE08, WE09, WE10, WE15, WE16, WE17A, WE17B, WE17C, WE17D, WE17E, WE17F, WE18A, WE18B, WE18C, WE18D, WE19A, WE19B, WE19C, WE20A, WE20B, WE21A, WE21B	▪ Around landfill perimeter	▪ To determine the nature of chemicals in soil in the vicinity of the landfill

Table 3-3 Chronology of Soil Characterization Activities, Hunters Point Shipyard Parcel E-2, Remedial Investigation/Feasibility Study (Continued)

Investigation Phase	Date	Sample Type(s)	Sample ID(s)	General Location	Sampling Purpose
SDGI, Shoreline Soil Sampling	September 2002 to February 2003	Surface Samples	IR01SH023, IR01SH027, IR01SH030, IR01SH033, IR01SH036, IR01SH039, IR02SH001	▪ Along bayward side of sheetpile wall	▪ To characterize the landfill/shoreline interface
SDGI, Onshore Soil Sampling	September 2002 to February 2003	Soil Borings	IR01B366 through IR01B399, IR02B402, IR02B404, IR02B409, IR02B434, IR02B435, IR02B437, IR02B438, IR02B449, IR02B452, IR02B470, IR02B512, IR02B515, IR02B517, IR02B526, IR12B037 through IR12B042	▪ Throughout Parcel E-2 (in areas adjacent to landfill) ▪ Portions of adjacent IR Sites 02 and 12	▪ To bound known source area or single-point location. ▪ To bound potential source identified in aerial photographs.

Notes:

*	Sample location within Landfill Area
IR	Installation Restoration
NDGI	Non-standard data gaps investigation
RI	Remedial Investigation
SDGI	Standard data gaps investigation
VOC	volatile organic compound

Table 3-4 Chronology of Groundwater Characterization Activities, Hunters Point Shipyard Parcel E-2, Remedial Investigation/Feasibility Study

Investigation Phase	Date	Sample Type(s)	Sample ID(s)	General Location	Sampling Purpose
Confirmation Study Verification Step	September 1986	Monitoring Well Installation	IR01MWI-1, IR01MWI-2, IR01MWI-3, IR01MWI-4, IR01MWI-5, IR01MWI-6, IR01MWI-7, IR01MWI-8, IR01MWI-9	▪ Throughout IR-01/21	▪ Confirmation study / verification setup
RI, Phase II, Primary Sampling Activities	October 1990	Monitoring Well Installation	IR01MW42A*, IR01MW48A	▪ East perimeter of Parcel E-2 ▪ Central portion of Parcel E-2 near the shoreline	▪ Calculate hydraulic gradients ▪ Estimate the nature and extent of hazardous substances in the A-aquifer
RI, Phase II, Primary Sampling Activities	October to November 1990	Grab Groundwater Samples[1]	IR01B039*, IR01B050, IR01B061, IR01B064	▪ Throughout IR-01/21	▪ Assess groundwater quality in the A-aquifer ▪ Locate future monitoring wells
RI, Phase II, Primary Sampling Activities	March to April 1991	Monitoring Well Installation	IR01MW02B*, IR01MW03A*, IR01MW07A, IR01MW26B*, IR01MW38A*, IR01MW43A*, IR01MW44A, IR01MW53B, IR01MW58A	▪ North perimeter of Parcel E-2 ▪ Shoreline of IR-01/21	▪ Calculate hydraulic gradients ▪ Evaluate the nature and extent of hazardous substances in the A-aquifer ▪ Monitor B-aquifer water quality
RI, Phase III, Contingency Sampling Activities	December 1991 to January 1992	Monitoring Well Installation	IR01MW17B*, IR01MW47B, IR01MW62A, IR01MW63A	▪ North portion of Parcel E-2 ▪ Southeast corner of Parcel E-2 near the shoreline ▪ Southwest corner of Parcel E-2 near the shoreline	▪ Evaluate the nature and extent of hazardous substances in the A-aquifer ▪ Evaluate groundwater flow from the west corner of the site

Table 3-4 Chronology of Groundwater Characterization Activities, Hunters Point Shipyard Parcel E-2, Remedial Investigation/Feasibility Study (Continued)

Investigation Phase	Date	Sample Type(s)	Sample ID(s)	General Location	Sampling Purpose
RI, Phase III, Contingency Sampling Activities	April to May 1992	Monitoring Well Installation	IR01MW05A*, IR01MW16A*, IR01MW18A*, IR01MW31A*	▪ North portion of IR-01/21 ▪ Central portion of IR-01/21	▪ Evaluate the nature and extent of hazardous substances in the A-aquifer ▪ Evaluate groundwater flow from the northwest corner of the site
RI, Phase III, Contingency Sampling Activities	April to June 1992	Grab Groundwater Samples[1]	IR01B011*, IR01B012*, IR01B021*, IR01B030*, IR01B274, IR01B275*	▪ Throughout IR-01/21	▪ Assess groundwater quality in the A-aquifer ▪ Locate future monitoring wells
RI, Supplemental Sampling Activities	October 1995	Monitoring Well Installation	IR01MW367A	▪ East perimeter of Parcel E-2	▪ Better characterize the nature and extent of hazardous substances in the A-aquifer
RI, Supplemental Sampling Activities	June 1996	Monitoring Well Installation and Hydropunch Groundwater Sample[1]	IR01MW400A, IR01MW401A, IR01MW402A, IR01MW403A, IR76B002	▪ West perimeter of the site ▪ Northeast corner of IR-01/21	▪ Measure the groundwater gradient along the W boundary ▪ Assess groundwater quality
Groundwater Data Gaps Investigation	October 2002	Monitoring Well Installation	IR01MW10A, IR01MW11A, and IR01MW12A	▪ Northeast corner of IR-01/21	▪ Measure groundwater levels and water quality adjacent to landfill gas barrier
Groundwater Data Gaps Investigation	October 2002	Piezometer Installation	IR01P04A	▪ Northeast corner of IR-01/21	▪ Measure groundwater levels adjacent to landfill gas barrier (replacement for decommissioned IR01P03A)
Groundwater Monitoring Program	June 2004	Monitoring Well Installation	IR01MW366B, IR01MW403B, IR01MWLF1A, IR01MWLF2A, IR01MWLF4A, and IR01MWLF4B	▪ Adjacent to landfill area	▪ To supplement monitoring well network (per Title 27 CCR)

Notes:

1 Sample collected from soil boring
* Sample location within Landfill Area
RI Remedial Investigation
IR Installation Restoration
CCR California Code of Regulations