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PRC

April 30, 1996

David Song
Engineering Field Activity West
Naval Facilities Engineering Command
900 Commodore Drive, Building 208
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Subject: Transmittal of the Parcel E Remediation Alternative Analysis, Technical Memorandum, Hunters Point Annex, San Francisco, California
CLEAN Contract No. N62474-88-D-5086 (CLEAN I), CTO No. 310

Dear Mr. Song:

By direction of the Navy, enclosed is a revised copy of the technical memorandum which documents the analysis of three alternatives to remediate IR-01/21, IR-02, and IR-03 in Parcel E.

This technical memorandum estimates the containment costs assuming that a slurry wall would be constructed. However, the recent draft engineering evaluation/cost analysis for a smaller groundwater plume at IR-01/21 determined that using sheet piling would be a better technology for containing groundwater than a slurry wall.

If you have any questions, please call me at (415) 222-8344.

Sincerely,

James Sickles

Jim Sickles
Installation Coordinator

Enclosure

cc: Anna-Marie Cook, EPA
Richard Hiett, RWQCB
Cyrus Shabahari, DTSC

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TECHNICAL MEMORANDUM

DATE: April 30, 1996

TO: Dave Song

FROM: Jim Sickles

SUBJECT: Parcel E Remediation Alternative Analysis

INTRODUCTION

PRC Environmental Management, Inc. (PRC) received Contract Task Order (CTO) No. 310 from the Department of the Navy, Engineering Field Activity West (EFA West), Naval Facilities Engineering Command, under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62474-88-D-5086. As part of the technical support under this CTO, PRC is tasked to prepare a technical memorandum documenting potential remedial design alternatives to be implemented within Parcel E at Hunters Point Annex (HPA).

The purpose of this technical memorandum is to identify the implementability, effectiveness, cost, and public acceptance of three remedial action alternatives identified by the Navy for three installation restoration (IR) sites: IR-01/21, IR-02, and IR-03. This memorandum provides (1) a site description of the three IR sites, (2) a discussion of the remedial action alternatives, (3) an evaluation of the remedial action alternatives, and (4) a table summarizing the evaluation.

SITE DESCRIPTIONS

The site descriptions provide information about physical characteristics, development, history, and contaminants.

Site IR-01/21

The Industrial Landfill, site IR-01/21, is a 36-acre, horseshoe-shaped area along the southwestern shoreline of HPA. IR-01/21 contains Triple A sites 1 and 16 (0.23 acre and 18 acres, respectively). The filling history of the IR-01/21 is not well documented. Aerial photographs indicate that filling of the bay on the eastern side of IR-01/21 began in the 1940s. A wide slough extended from the bay to the northern corner of the site; between 1958 and 1974, the Navy filled the slough area with shipyard wastes. By 1974, the Navy had completed filling the slough, and the entire site was capped with several feet of clean fill. Triple A Machine Shop sites 1 and 16 lie within IR-01/21. During Triple A's occupancy, unlabeled drums were stored at Triple A site 1 for an unknown period of time. Ground staining was observed in the vicinity of the drums, which were later removed by Triple A. Disposal of industrial debris and sand blast waste was conducted at Triple A site 16 on the shoreline adjacent to the south access road (HLA 1993).

Nearly all of the areas with concentrations of hazardous substances or petroleum hydrocarbons are found in the artificial fill overlying bay mud deposits. The hazardous substances at IR-01/21 are volatile organic compounds (VOC), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), total petroleum hydrocarbons (TPH), and metals.

Triple A reportedly disposed of sandblast waste in this area. The vertical and lateral extent of sandblast material noted in boring logs appears to correlate closely with the areas identified with concentrations of metals (HLA 1993).

Several radioactive point sources were detected at the surface within IR-01/21 during a radiation survey performed in 1992. Gamma spectroscopic analysis was performed on soil samples collected during this survey and found that the source of the radioactivity was radium-226 and its progeny (PRC 1996).

Subsequently, in winter 1993, an investigation of the subsurface distribution of radioactive material was implemented. Six 15-foot trenches were excavated until native soil or groundwater was encountered. No radioactive material was detected in subsurface soils (PRC 1996).

The Navy has concluded that the existence of radium-containing material in surface soils at IR-01/21 is due to general disposal activities. The Navy speculates that the original disposal site for point sources detected at the surface in IR-01/21 but that the sources have been relocated as a result of storage and disposal activities within the landfill areas.

Site IR-02

The Bay Fill Area, site IR-02, is southeast of the Industrial Landfill (IR-01/21) and comprises most of the south shoreline area of HPA. It is a long, narrow area of about 47 acres.

IR-02 was filled in about the same manner as the early filling at IR-01/21. From 1945 to 1978, the south shoreline of HPA was used as a site for disposal of sandblast waste, paint scrapings, and other debris. Triple A disposed of the following wastes at IR-02:

- Industrial debris, drums, paint cans, pipe lagging, and asphalt (Triple A sites 2, 14, and 18)
- Sandblast and liquid wastes (Triple A site 17, a portion of which is in site IR-03)
- Waste oil containing PCBs (Triple A site 13)
- Oil and other liquids (Triple A site 19) (HLA 1993)

During an HLA characterization of the landfill areas in 1991, elevated gamma activity was detected in surface soils. Based on these findings, a surface radiation survey was conducted in 1992, which identified over 300 point sources in surface soils at IR-02. Trenching activities at both IR-01/21 and the Bay Fill Area (IR-02) showed that the disposal of industrial debris (e.g., instrumentation, ship parts, and piping) predominantly occurred within an area about 400 feet by 250 feet in IR-02; and this is where most all of the surface and all the subsurface radioactive point sources were detected. Gamma spectroscopic analysis performed on soil samples collected during this survey found that the source of the radioactivity was radium-226 and its progeny (PRC 1992).

Subsequently, in winter 1993, an investigation of the subsurface distribution of radioactive material was implemented. Forty-two 15-foot test pits and three 100-foot trenches were excavated in IR-02 until native soils or groundwater were encountered. One hundred eleven radioactive point sources, at a maximum depth of 9 feet bgs, were identified during the subsurface radiation survey. All radioactive material was detected within fill material. No material was found in native soil (i.e., the bay mud).

The radioactive material disposal appeared to have occurred within an area measuring about 400 feet long by 250 feet wide. The volume of soil in IR-02 that contains radium-containing material was calculated to be about 5,500 cubic yards with an estimated aggregate radium-226 activity of 2.8 millicuries (PRC 1996).

Site IR-03

The Oil Reclamation Ponds, site IR-03, is in the eastern part of the southern shoreline and is completely surrounded by IR-02. It is a small, semirectangular area of about 1 acre.

The Navy operated two oil reclamation ponds on the south shore of HPA from 1944 to 1974. The ponds were unlined and were constructed in fill material about 30 feet from the shoreline. Oily wastes generated from ships and other shipyard operations were hauled by truck or were pumped through a pipeline from berth 29 to the ponds for disposal. Reclaimed oil was removed about three times each year. WESTEC reported that one pond was 50 by 60 feet by 5 feet deep and had a capacity of 190,000 gallons and the other was 55 by 100 feet by 5 feet deep with capacity of 250,000 gallons. The ponds were filled by the Navy in 1974.

Triple A site 17, the location of sandblast and liquid waste disposal, covers all of IR-03 and a portion of adjoining IR-02. Ground staining is still present in some areas (HLA 1993).

REMEDIAL ACTION ALTERNATIVES

Site-specific data were reviewed so that potential alternatives for this remedial action could be identified, developed, and evaluated. As discussed previously, the hazardous substances at IR-01/21, IR-02, and IR-03 are VOCs, PAHs, PCBs, metals, and radionuclides. In addition, TPH has been detected in soil at these sites. Remedial technologies identified by the Navy were assembled into alternatives, which are comprehensive remedial action plans incorporating one or more specific technologies related to soil remediation. Then, the alternatives were evaluated and a comparative analysis was performed.

Development of Remedial Action Alternatives

The following general response actions for remediation of soils at the IR-01/21, IR-02, and IR-03 have been evaluated in this technical memorandum.

- Containment actions
  - Capping
  - Slurry wall
- Removal and disposal actions
  - Excavation
  - Class I facility disposal
  - Radioactive waste disposal
- Ex Situ treatment actions
  - Incineration
  - Stabilization and solidification
  - Segregation of radium dials

Landfill materials containing hazardous substances and TPH were the focus of the remedial alternative identification and development. Except for slurry walls, technologies considered only address hazardous substances in soil, and some institutional actions would be necessary to limit groundwater use. Groundwater conditions, however, were not evaluated, and institutional actions for groundwater use are not addressed in this technical memorandum due to the focused nature of the scope of this study. Please note that the proposed engineering evaluation/cost analysis (EE/CA) for the groundwater removal action at IR-01/21 (PRC 1996) discusses an approach to groundwater control on a limited scale which could be evaluated for comparative purposes.

Ex situ treatment technologies, such as incineration or stabilization and solidification, would be in the disposal action and performed at the treatment, storage, and disposal facility (TSDF), as needed, to meet land disposal restrictions (LDR).

The following remedial action alternatives, which were based on site data and direction from the Navy, have been developed for remediating soils at IR-01/21, IR-02, and IR-03:

Alternative 1	-	Capping and slurry wall containment
Alternative 2	-	Excavation and off-site stabilization and solidification and disposal of radioactive material and associated chemical contamination only
Alternative 3	-	Excavation, segregation of radium dials, and off-site stabilization and solidification and disposal of radioactive material and associated chemical contamination only

Remedial Action Alternatives

The remedial action alternatives are described in the following sections. The assumptions used for key design factors necessary to evaluate the alternatives also are discussed.

Alternative 1 - Capping and Slurry Wall Containment

Alternative 1 is capping and slurry wall containment. The presumptive remedy for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) municipal landfill sites relates primarily to containment of the landfill mass and collection and treatment of landfill gas. Components of the presumptive remedy for source containment may include the following components: landfill cap, source area groundwater control to contain plume, leachate collection and treatment, landfill gas collection and treatment, and institutional controls to supplement engineering controls (U.S. Environmental Protection Agency [EPA] 1993).

The landfill cap proposed for HPA Parcel E is a multi-layer Resource Conservation and Recovery Act (RCRA) Subtitle C compliant cover consisting of a low hydraulic conductivity geomembrane soil layer, a drainage layer, and a top vegetation soil layer (EPA 1991). Clean fill would be placed and compacted over the landfill areas to establish the necessary grade for drainage.

In addition, alternative 1 has a slurry wall installed along the coastline of IR-01/21, IR-02, and IR-03 to minimize migration of hazardous substances in groundwater to sediments and surface water in the San Francisco Bay. The slurry wall would act as a low-permeability barrier and prevent the hazardous substances in groundwater from migrating off site. Slurry walls are typically composed of mixtures of soil and bentonite or mixtures of cement and bentonite and have a lower permeability than the aquifer. The slurry wall would be keyed into the bay mud confining clay layer below the unconfined aquifer.

The following assumptions were made to support the evaluation of alternative 1:

- The multi-layer cap would cover 35 acres at site IR-01/21, 47 acres at site IR-02, and 1 acre at site IR-03. Previous sampling results indicate that hazardous substances, especially metals, are distributed throughout the landfills. Therefore, the total area of IR-01/21, IR-02, and IR-03 would be capped and would cover about 83 acres.

- The multi-layer cap would consist of the following components from bottom to top:

    (1) 24-inch layer of clay

    (2) 80-mil high-density polyethylene (HDPE) synthetic membrane liner

    (3) Geotextile and geonet, synthetic drainage media

    (4) 24-inch layer of top soil with vegetation

- The slurry wall would extend the length of the coastline along Parcel E, a linear distance of about 7,500 feet.

- The slurry wall would be installed at least 2 feet into the Bay Mud clay layer underlining aquifer A at Parcel E. The average bay mud surface elevation observed in monitoring wells in Parcel E was 23.5 feet bgs. Therefore, the total depth of the slurry wall was assumed to be 25 feet bgs.

- Depending on site-specific hydrogeologic conditions, active groundwater gradient control by pumping and treating may be required to control groundwater flow after the slurry wall is installed. The cap would limit recharge to the landfill area but may not significantly change the groundwater gradient. Groundwater flow would be altered by the slurry wall and may flow around the edges. However, until further groundwater evaluation is performed, groundwater gradient control is not included in alternative 1.

Alternative 2 - Excavation and Off-Site Stabilization and Solidification and Disposal of Radioactive Material

Alternative 2 involves (1) excavation of all soil containing radioactive devices, using standard construction equipment, and (2) off-site stabilization and solidification and disposal. Only the landfill areas identified as locations of radioactive point sources would be excavated. The volume of soil containing radioactive point sources was estimated at 5,500 cubic yards during a subsurface radiation investigation (PRC 1996). Radioactivity was detected from ground surface to 9 feet bgs. Sloping would be required during excavation due to the 9-foot depth of excavation. Including a swell factor, about 6,050 cubic yards of radioactively affected soil would be transported to a radioactive waste disposal facility for off-site stabilization and solidification and disposal.

A description of specific activities associated with this remedial action alternative follows. Excavation of landfill materials is included in alternatives 2 and 3; therefore, its discussion, which appears in alternative 2, is applicable to alternative 3 also.

Excavation. Soils at IR-01/21, IR-02, and IR-03 would be excavated and hauled using conventional earthwork equipment. Chemical analysis would be required at the time of soil excavation to determine whether treatment is necessary pursuant to the LDRs set forth in Title 40 of the Code of Federal Regulations (CFR) Part 268. Activities associated with soil excavation are as follows:

- Mobilization and Preparation. Mobilization consists of all activities associated with mobilizing equipment to IR-01/21, IR-02, and IR-03 and preparation of staging areas. Site preparation would involve decommissioning utilities, removing necessary portions of site fencing, mobilizing an on-site segregation system, and performing preliminary earthwork necessary for excavation. Site preparation work also entails construction of a temporary chain-link fence with gates to surround the proposed excavation area to prevent unauthorized access.

- Sloping and Shoring. The excavation depth at the HPA is anticipated to be 10 feet; therefore, sloping or shoring would be required.

- Excavation. Soil would be excavated using backhoes, front-end loaders, scrapers, bulldozers, or other earthwork equipment. Soil removed from the excavation would be temporarily stockpiled on visqueen at an adjacent area. Subsequently, soil would be transferred to and stockpiled at a designated area for on-site segregation or off-site treatment and disposal, as appropriate. Radioactive materials would be stockpiled in a separate area, and additional health and safety monitoring would be performed.

- Sampling. Confirmation sampling involves screening-level and final confirmation sampling. Screening-level samples would be collected after the initial excavation extent has been reached to determine whether additional excavation would be required. Upon completion of the excavation, final confirmation samples would be collected for verification. The final confirmation samples would assess the residual hazardous substances and petroleum hydrocarbon concentrations in soil. Screening level and final confirmation sampling would be assumed to include the collection of one sample per each 10,000 square feet of the excavation bottom and one sample from each 100 feet of side walls.

- Backfill and Compaction. When the excavation is completed, the excavated area would be backfilled and compacted with clean soil. Following backfill and compaction, the remedial action for IR-01/21, IR-02, and IR-03 would be complete.

- Demobilization. All equipment would be decontaminated, and fences would be removed before treatment crews leave the site.

Additional measures would be applied when excavating and handling radioactive materials. As the excavation proceeds, materials would be excavated with the bucket of the backhoe and screened with remote sensors for radiological or health and safety monitoring. Then, the materials would be placed in a staging area for screening, radium dial segregation, or disposal.

The following assumptions concerning excavation activities and soil properties apply to alternatives 2 and 3:

- Dewatering of the excavation would not be required because the excavation would not extend below the water table.
- A 10 percent swell factor is assumed to convert bank soil volume to loose soil volume.
- The density of the landfill waste is assumed to be 100 pounds per cubic foot or 1.35 tons per cubic yard.

Off-Site Stabilization and Solidification. Stabilization and solidification refer to treatment processes that are designed to (1) improve the handling and physical characteristics of the waste, (2) decrease the surface area of the waste mass across which transfer or loss of contaminants can occur, or (3) limit the solubility of any hazardous constituents of the waste (EPA 1986). Stabilization techniques primarily limit the solubility or mobility of the hazardous constituents with or without change or improvement in the physical characteristics of the soil. Stabilization usually involves adding materials to ensure that the hazardous constituents are maintained in their least mobile or toxic form. Solidification produces a solid block of waste material that has high structural integrity and can encompass the hazardous constituents. Stabilization and solidification would be required of toxicity characteristic hazardous waste to meet RCRA land disposal restrictions. Stabilization and solidification might also be required of radioactive waste in order to meet disposal criteria.

The following assumptions were made to support the evaluation of alternative 2:

- The excavation area would be limited to materials containing radium, and the excavation depth would extend to 9 feet bgs, as defined by the subsurface radiation investigation (PRC 1996).
- The total bank volume of materials containing radium to be excavated would be about 5,500 cubic yards. The total loose volume of disposal materials containing radium would be about 6,050 cubic yards.
- Nonradioactive materials would remain in place.
- The total volume of low-level radioactive material for disposal in a radioactive waste disposal facility is about 6,050 cubic yards or 8,168 tons.

- The round-trip distance for radioactive waste transportation from HPA to the Envirocare radioactive waste disposal facility in Clive, Utah, is about 1,200 miles.

- A 25 percent discount factor would be applied to disposal unit costs due to the large disposal material volume and economies of scale.

Alternative 3 - Excavation, Segregation of Radium Dials, and Off-Site Stabilization and Solidification and Disposal of Radioactive Material

Alternative 3 involves (1) excavation of all soil containing radioactive devices using standard construction equipment; (2) separation of radioactive contamination point sources, such as radium dials, with a grizzly screen and vibrating screens; and (3) off-site disposal. Only the landfill areas identified as locations of radioactive point sources would be excavated. The volume of soil containing radioactive point sources was estimated at 5,500 cubic yards and extended from ground surface to 9 feet bgs (PRC 1996). Sloping would be required during excavation due to the 9 foot depth of excavation. Including a swell factor, about 6,050 cubic yards of radioactively affected soil would undergo radium dial segregation by physical screening. A 50 percent low-level radioactive material volume reduction through radium dial segregation would be assumed. About 3,025 cubic yards of radioactively affected soil, including radium point sources, would be transported to a permitted radioactive waste disposal facility for off-site stabilization and solidification and disposal. About 3,025 cubic yards or 4,084 tons of soil containing nonradioactive hazardous substances would be transported to an off-site Class I landfill for disposal.

A description of specific activities to be performed during this remedial action alternative follows.

Excavation. Excavation activities associated with this alternative would be as described in alternative 2, and the excavation would be backfilled with clean soil.

Segregation of Radium Dials. Separation technologies are intended to make the waste stream uniform or to isolate a portion of the waste stream for treatment. Screening is a mechanical separation process that is based on particle size differences. The screen is a simple device used for grading or separating of particles by size. Radium dials would be removed from the landfill wastes by sorting using screens of different sizes. The radium dials and buttons range in size from about 0.25 inch to 2.5 inches in diameter.

Only the landfill areas identified as locations of surface radioactive point sources in the 1992 surface contamination survey would be sorted for radium dials. These areas are plotted in the results of the subsurface radiation investigation in Parcels B and E (PRC 1996).

Waste sorting would be accomplished in several steps. In step 1, excavated soils from radioactive point source locations would be initially subject to grizzly screening. The grizzly screen is a static bar screen that separates waste forms larger than 6 inches. The grizzly screen is angled to allow large materials to roll off the screen. In step 2, the large debris would be analyzed for radioactivity prior to disposal. In step 3, materials less than 6 inches would be screened further, and the material greater than 2.5 inches would be removed on a vibrating screen. In step 4, materials less than 2.5 inches would be screened further using a vibrating screen with 0.25-inch openings to allow material finer than fine gravel to pass. The waste fraction from 0.25 inch to 2.5 inches would include the radium dials and buttons and would be handled separately. All fraction sizes will be evaluated for radioactivity prior to disposal. Alternative techniques to segregate the radium point sources may be employed depending on physical and chemical conditions of the excavated materials.

Off-Site Stabilization and Solidification. Treatment activities associated with this alternative would be as described in alternative 2. Stabilization and solidification would be required for RCRA toxicity characteristic hazardous waste or radioactive waste disposal.

The following assumptions were made to support the evaluation of alternative 3:

- The excavation area would be limited to materials containing radium, and the excavation depth will extend to 9 feet bgs, as defined by the subsurface radiation investigations (PRC 1996).
- The total bank volume of soil containing radioactive devices to be excavated would be about 5,500 cubic yards.
- Nonradioactive materials would remain in place.
- Waste containing radium dials and buttons would be segregated using grizzly screens and vibrating screens, and segregation would achieve a 50 percent low-level radioactive waste volume reduction.
- The total volume of low-level radioactive disposal waste transported to a radioactive waste disposal facility, assuming a 10 percent swell factor, would be about 3,025 cubic yards or 4,084 tons.
- The total volume of disposal wastes transported to a Class I landfill would be 3,025 cubic yards or 4,084 tons.
- The round-trip distance for radioactive waste transportation from HPA to the Envirocare radioactive waste disposal facility in Clive, Utah, would be about 1,200 miles.
- The round-trip distance for hazardous waste transportation from HPA to the Chemical Waste Management Class I landfill in Kettleman Hills, California, would be about 325 miles.

- A 25 percent discount factor would be applied to disposal unit costs due to the large volume of disposal material and economies of scale.

EVALUATION OF REMEDIAL ACTION ALTERNATIVES

This section describes the evaluation criteria and analysis of remedial action alternatives. The remedial alternatives were further evaluated and compared to provide the basis for selecting a preferred remedial alternative.

Evaluation Criteria

The following four criteria were used to evaluate the identified remedial action alternatives: (1) effectiveness, (2) implementability, (3) cost, and (4) state and community acceptance. All remedial action alternatives were evaluated in detail. For each alternative, the area and volume of affected soil, the technologies used, any associated performance requirements, and the assumptions used in establishing costs were evaluated. A description of the evaluation criteria follows.

1. Effectiveness

The effectiveness of an alternative refers to its ability to meet the objectives within the scope of the remedial action. In particular, these objectives should address (1) overall protection of human health and the environment; (2) ability to achieve the target cleanup levels; (3) reduction of toxicity, mobility, or volume through treatment; and (4) long-term effectiveness and permanence.

2. Implementability

The implementability criterion encompasses the technical and administrative feasibility of implementing an alternative and the availability of the various services and materials required. Technical feasibility is used to eliminate those alternatives that are clearly impractical at a site. Administrative feasibility relates to those activities requiring coordination with other offices and agencies. The remedial action alternative evaluation must determine whether off-site treatment, storage, and disposal capacity; equipment; personnel; services and materials; and other resources necessary to implement an alternative are available, as needed, to maintain the remedial action schedule.

3. Cost

Each remedial action alternative is evaluated to determine its projected costs, evaluating capital and operation and maintenance costs. These costs are based on published cost data, vendor estimates, disposal facility fees, and estimates for similar projects. The final cost should fall within plus 50 percent to minus 30 percent of the estimated cost.

4. State and Community Acceptance

Each remedial action alternative is evaluated to determine the technical and administrative issues and concerns that the state or community may have.

Analysis of Remedial Action Alternatives

All remedial action alternatives were evaluated according to effectiveness, implementability, estimated cost and state and community acceptance criteria. The analysis of remedial alternatives was based on any necessary assumptions regarding its conceptual design and operational parameters as discussed previously. Table 1 shows a summary of the results.

1. Effectiveness

Alternative 1 includes containment of affected soil by capping and would protect human health and the environment by reducing long-term exposure and migration. Capping would not achieve cleanup goals, but would reduce hazardous substance mobility in the unsaturated zone by reducing infiltration. A maintained, engineered cap would provide long-term protection, but would be ineffective for soils in the saturated zone. Hazardous substances in soil below the water table could still migrate in groundwater. The slurry wall, however, would provide a low-permeable, downgradient barrier and would provide an effective method to inhibit groundwater from discharging to surface water and sediments in the San Francisco Bay; therefore, it would minimize human and ecological exposure. Toxicity and volume of some hazardous substances and petroleum hydrocarbons under the cap would slowly be reduced through natural biological degradation and radioactivity decay. Land use restrictions would preserve the integrity of the cap.

Alternatives 2 and 3 include excavating the landfill areas identified as locations of radioactive point sources. Landfill material containing nonradioactive hazardous substances would remain in place. Groundwater treatment

TABLE 1

REMEDIAL ACTION ALTERNATIVE EVALUATION SUMMARY
PARCEL E - IR 1/21, 2, AND 3
HUNTERS POINT ANNEX

Number	Remedial Action Alternative	Effectiveness	Implementability	Cost ($) (000,000)	State and Public Acceptance
1	Capping with Slurry Wall Containment	*Immobilize hazardous substances in unsaturated zone *Contain hazardous substances in groundwater *Reduce exposure *Contaminants not treated *Presumptive remedy	*Proven methods, materials available *Slurry wall impacted by permeable native soil *O&M required *Land use restrictions *Minimal worker exposure	193.8	*Limit future land use *Groundwater use restriction * Wastes remain on site *Acceptance depends on confidence in engineered containment
2	Excavation of Radioactive Material, Off-Site Stabilization/Solidification (S/S) Disposal	*Remove radioactive material *Non-radioactive remains in place *Off-site landfill S/S disposal *Reduce exposure and risk *Groundwater not treated	*Radioactive material handling *Equipment available *Transport waste *Radioactive waste disposal may be affected by organics	18.9	*Groundwater use restriction *Limited acceptance *Non-radioactive substances not addressed
3	Excavation of Radioactive Material, Segregation of Radium Dials, Off-Site S/S Disposal	*Remove radioactive material *Non-radioactive remains in place *Radioactive point source segregation may not be effective *Off-site landfill S/S disposal *Reduce exposure and risk *Groundwater not treated	*Radioactive material handling *Equipment available *Transport waste *Radium dial segregation difficult *Radioactive waste disposal may be affected by organics	10.9	*Groundwater use restriction *Limited acceptance *Non-radioactive substances not addressed

or containment is not included in these alternatives. Radioactively affected soil would be effectively immobilized by off-site stabilization and solidification and disposal. Alternatives 2 and 3 would not protect human health and the environment from nonradioactive hazardous substances and would not achieve cleanup goals or reduce toxicity, mobility, or volume of nonradioactive hazardous substances. Alternatives 2 and 3 would not provide long-term effectiveness because hazardous substances would migrate from soil to groundwater and surface water.

2. Implementability

Alternative 1 includes landfill cap and slurry wall installation, which are reliable, proven methods of containment. Slurry wall installation can be affected by course or fractured native materials that are too permeable to retain the slurry in the trench. Geotechnical analysis of the surrounding materials would have to be performed as part of the slurry wall design. Specialists, equipment and materials would be available. Additional remedial actions or soil monitoring underneath the cap would not be feasible once the cap was in place. Base operations would not be disturbed. Long-term maintenance would be required. Land use restrictions would be implemented to prevent construction on capped areas.

Alternatives 2 and 3 include excavation and off-site disposal. Excavation for these alternatives is implementable. Treatment of HPA IR-01/21, IR-02, and IR-03 soil is subject to the requirements of RCRA. Disposal of radioactive waste may be affected by high organic concentrations. Specialists, equipment, and materials would be available for these alternatives.

Alternative 3 includes segregation of radium point sources. Segregation of radium dials may not result in volume reduction of low-level radioactive wastes based on the particle-size and radionuclide distribution of soil samples collected from test pits and trenches in IR-02. Radium dials may have been damaged by landfill disposal or may be damaged during excavation, causing reduction in size or chipping of radium paint on the dials. Changes in physical characteristics of the radium dials will decrease the effectiveness of mechanical screening. In addition, a radioactive waste disposal facility representative stated that segregation of the radioactive source (2,350 picocuries per gram of radium-226 measured in radium dial source fragment) from the radioactively affected media (0.95 to 318 picocuries per gram of radium-226 measured in whole soil samples) will not improve waste handling, transportation, or disposal. Therefore the effectiveness of radium dial segregation is low.

3. Cost

Total costs of each alternative appear in tables in Appendix A. The tables identify the work breakdown structure (WBS) code, item or description, unit, unit cost, quantity, and total.

Alternative 1 total costs are associated with capping and slurry wall containment and were estimated at $193.865 million. Detailed costs are presented in Table A-1. The majority of the costs for this alternative are due to capping the large areas of IR-01/21, IR-02, and IR-03 and using off-site materials. Alternate cap designs would be evaluated during remedial design phase and could reduce costs for this alternative.

Alternative 2 total costs are associated with excavation of radioactive materials and off-site disposal and were estimated at $18.931 million. Detailed costs are presented in Table A-2.

Alternative 3 total costs are associated with excavation of radioactive materials, segregation of radium dials, and off-site disposal and were estimated at $10.989 million. Detailed costs are presented in Table A-3.

The costs estimate does not include costs associated with groundwater collection and discharge. However, the recent draft EE/CA for the groundwater plume at IR-01/21 estimates these costs at $343,000. The EE/CA assumes that well points will collect water along 600 linear feet of sheet piling and discharge to the local publicly owned treatment works for a period of three years. It is estimated that the linear distance along Parcel E is 7,500 feet.

4. State and Community Acceptance

Alternative 1 includes only containment by capping and a slurry wall. Landfill materials containing hazardous substances would remain in place. Hazardous substances present include radionuclides with long half-lives which may cause concern in the community over potential future releases. The primary pathway for exposure for these radium dials would consist of inhalation of radium contaminated dust. Since the radium dials are currently buried and no radium has been found in the groundwater the remedy of an engineered containment would serve to break this exposure pathway. State and community confidence in engineered containment of hazardous and radioactive substances would determine the level of acceptance. The Navy would possibly retain ownership of Parcel E due to containment of radioactive materials on site. Land use restrictions necessary to preserve the integrity of the cap would limit future land use and redevelopment at Parcel E.

Alternatives 2 and 3 include removal and off-site disposal of radioactive materials and may alleviate the most serious cause for concern in the community over potential future releases; however, nonradioactive landfill materials containing hazardous substances would remain in place and would have the potential to migrate off site. Alternatives 2 and 3 may have only limited acceptance as a final remedy or qualified acceptance as an interim remedial measure.

Comparative Analysis of Remedial Action Alternatives

This section presents a comparative analysis of the remedial action alternatives. The objective of the comparative analysis is to assess the relative performance of each alternative with respect to the evaluation criteria to select a preferred alternative.

Alternative 1 would provide a high level of protection by containing migration of hazardous substances in the unsaturated and saturated zones. Alternative 1 is the only alternative that addresses the migration of hazardous substances in groundwater. However, this alternative does not account for removing groundwater to relieve pressure on the slurry wall and the rise of the groundwater level, which are consequences to the installation of a slurry wall. Alternatives 2 and 3 provide the lowest level of protection because these alternatives only address the radioactive materials. Nonradioactive substances are not addressed in alternatives 2 and 3.

Based on overall implementability, alternative 1 is the most implementable because it would address all soil containing hazardous substances and groundwater without disturbing the landfills; however, slurry wall installation may be affected by permeable native soil. Alternatives 2 and 3 are technically implementable, including special procedures necessary to handle radioactive materials. Alternatives 2 and 3 are implementable for radioactive materials only. Segregation of radium dials by mechanical screening included in alternative 3 may be difficult due to potential size variation of radium dials and fragments.

Costs associated with alternative 1 are high due to the large size of IR-01/21, IR-02, and IR-03 and the nature of hazardous substances and petroleum hydrocarbons present at the IR sites. Costs for alternatives 2 and 3 are lower because these alternatives only address radioactive materials and asssociated chemical contamination. Based on overall costs, alternative 3 is the least expensive followed by alternative 2. Alternative 1 is most expensive.

Based on overall state and community acceptance, alternative 1 would be moderately accepted because landfill materials would remain in place. Alternatives 2 and 3 would have greater acceptance because they remove the radioactive materials, but Alternatives 2 and 3 would have a lesser acceptance because they do not address media containing non radioactive hazardous substances.

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APPENDIX A

COST OPINION AND ASSUMPTIONS FOR REMEDIAL ACTION ALTERNATIVES

TABLE A-1

COST OPINION AND ASSUMPTIONS
REMEDIAL ACTION ALTERNATIVE 1
CAPPING AND SLURRY WALL CONTAINMENT
PARCEL E - SITES IR-01/21, IR-02, AND IR-03
HUNTERS POINT ANNEX

WBS Code	Item/Description	Unit	Unit Cost ($)	Quantity	Subtotal ($)	Total ($)
33.01	**Mobilization and Preparatory Work**					
33.01.01	Mobilize equipment	lump sum	30,000.00	1	30,000	
33.01.90	Prepare remedial action work plan	lump sum	35,000.00	1	35,000	
33.01.91	Prepare and evaluate bid	lump sum	100,000.00	1	100,000	
33.01.92	Permitting	lump sum	5,000.00	1	5,000	
	WBS Subtotal					**$170,000**
17	**Site Work**					
17.01.01.01	Clear light brush without grub	acre	44.53	83	3,696	
17.03.01.03	Rough grading	SY	0.43	401,720	172,740	
	WBS Subtotal					**$176,436**
33.06.03	**Slurry Walls**					
33.06.03.01	Level and compact working surface	CY	3.55	150,000	532,500	
33.06.03.02	Construct dike for mixing basin	CY	3.55	4,951	17,576	
33.06.03.05	Excavate slurry wall to 25 feet	CY	1.77	108,000	191,160	
33.06.03.09	Purchase Bentonite - 90 barrel yield	ton	185.52	5,751	1,066,926	
33.06.03.10	Mix, hydrate, and emplace slurry	gallon	0.02	21,738,750	434,775	
33.06.03.11	Mix soil-bentonite backfill	CY	2.07	108,000	223,063	
.06.03.12	Backfill slurry wall trench	CY	1.56	108,000	168,296	
33.06.03.13	Demolish mixing basins	SF	0.05	13,369	662	
	WBS Subtotal					**$2,634,958**
33.08	**Solids Collection and Containment**					
33.08.05	Capping of Waste Area					
33.08.05.07	Clay 10E-7, 6-inch lift, off site	CY	11.79	7,230,960	85,284,112	
33.08.05.71	80-Mil polymeric liner, HDPE	SF	1.87	3,615,480	6,760,948	
33.08.05.13	Drainage netting, geotextile fabric bonded	SF	0.65	3,615,480	2,344,277	
17.03.04.23	Unclassified fill, 6-inch lifts, off site	CY	7.15	7,230,960	51,701,364	
33.08.05.85	Sprayed water dust suppressant	SY	0.01	401,720	5,102	
	WBS Subtotal					**$146,095,802**
33.01	**Demobilization**					
33.01.01	Demobilize equipment	lump sum	20,000.00	1	20,000	
33.01.93	Prepare remedial action report	lump sum	30,000.00	1	30,000	
	WBS Subtotal					**$50,000**
	Total Direct Costs					**$149,127,196**
	Contingency (20% of direct costs)	(20%)				**$29,825,439**
	Project administration (10% of direct costs)	(10%)				**$14,912,720**
TOTAL COST ESTIMATE						**$193,865,354**

Notes: Unit costs include all labor, equipment, and material costs
Unit costs obtained from the ECHOS Environmental Restoration: Unit Cost Book and from vendor price quotes

CY Cubic yard SF Square feet SY Square yard HDPE High-density polyethylene

TABLE A-2

COST OPINION AND ASSUMPTIONS
REMEDIAL ACTION ALTERNATIVE 2
EXCAVATION OF RADIOACTIVE MATERIAL, OFF-SITE TREATMENT AND DISPOSAL
PARCEL E - SITES IR-01/21, IR-02, AND IR-03
HUNTERS POINT ANNEX

WBS Code	Item/Description	Unit	Unit Cost ($)	Quantity	Subtotal ($)	Total ($)
33.01	**Mobilization and Preparatory Work**					
33.01.01	Mobilize equipment	lump sum	30,000.00	1	30,000	
33.01.90	Prepare remedial action work plan	lump sum	35,000.00	1	35,000	
33.01.91	Prepare and evaluate bid	lump sum	50,000.00	1	50,000	
33.01.92	Permitting	lump sum	10,000.00	1	10,000	
	WBS Subtotal					**$125,000**
17	**Site Preparation**					
17.01	Site clearing					
17.01.0101	Clear light brush without grub	acre	44.54	6	267	
	WBS Subtotal					**$267**
33.02	**Monitoring, Sampling, Testing, and Analysis**					
33.02	grid					
33.02.0222	Screen for radioactivity	sample	123.69	300	37,107	
33.02.02357	Characterize unknown radioactive sample	sample	2,473.56	30	74,207	
33.02.1705	Soil lab analysis - TCLP metals	sample	165.11	100	16,511	
33.02.1714	Soil lab analysis - BTEX	sample	123.69	100	12,369	
33.02.1717	Soil lab analysis - PCBs	sample	213.96	100	21,396	
33.02.1722	Soil lab analysis - PAHs	sample	298.37	100	29,837	
33.02.1760	Soil lab analysis - metals, EA (8)	sample	148.41	100	14,841	
	WBS Subtotal					**$206,268**
17.03.02	**Common Excavation and Disposal**					
17.03.0219	3.73 CY track loader	hour	108.77	105	11,421	
17.03.0246	Scraper, 34 CY with D9 bulldozers	hour	283.47	105	29,764	
17.03.0423	Backfill, unclassified fill, 6-inch lift, off site	CY	7.15	6,050	43,258	
	WBS Subtotal					**$84,443**
33.19	**Disposal (Commercial)**					
33.19.0283	Radioactive truck haul 500+ miles roundtrip and 303 truck (20 CY) loads	mile	4.88	363,600	1,774,368	
33.19.0311	Truck washout	truck	185.51	303	56,210	
33.19.0317	Waste stream evaluation fee	EA	494.71	30	14,841	
33.19.90	Radioactive waste disposal	CY	2,025.00	6,050	12,251,250	
	WBS Subtotal					**$14,096,669**
33.21	**Demobilization**					
33.21.04	Demobilize equipment	lump sum	20,000.00	1	20,000	
33.21.06	Prepare removal action report	lump sum	30,000.00	1	30,000	
	WBS Subtotal					**$50,000**

TABLE A-2

COST OPINION AND ASSUMPTIONS
REMEDIAL ACTION ALTERNATIVE 2
EXCAVATION OF RADIOACTIVE MATERIAL, OFF-SITE TREATMENT AND DISPOSAL
PARCEL E - SITES IR-01/21, IR-02, AND IR-03
HUNTERS POINT ANNEX

WBS Code	Item/Description	Unit	Unit Cost ($)	Quantity	Subtotal ($)	Total ($)
	Total Direct Costs					**$14,562,647**
	Contingency (20% of direct costs)	(20%)				**$2,912,529**
	Project administration (10% of direct costs)	(10%)				**$1,456,265**
TOTAL COST ESTIMATE						**$18,931,441**

Notes:

Unit costs for all labor, equipment, and material costs

Unit costs obtained from the ECHOS Environmental Restoration: Unit Cost Book and from vendor price quotes

Radioactive waste disposal at Envirocare Radioactive Waste Disposal Facility in Clive, Utah

A 25 percent discount factor applied to disposal unit costs due to large volumes and economies of scale

CY	Cubic yard
BTEX	Benzene, toluene, ethylbenzene, and xylenes
EA	Each
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
TCLP	Toxic characteristic leachate procedure

TABLE A-3

COST OPINION AND ASSUMPTIONS
REMEDIAL ACTION ALTERNATIVE 3
EXCAVATION OF RADIOACTIVE MATERIAL, SEGREGATION OF RADIUM DIALS, OFF-SITE TREATMENT AND DISPOSAL
PARCEL E - SITES IR-01/21, IR-02, AND IR-03
HUNTERS POINT ANNEX

WBS Code	Item/Description	Unit	Unit Cost ($)	Quantity	Subtotal ($)	Total ($)
33.01	**Mobilization and Preparatory Work**					
33.01.01	Mobilize equipment	lump sum	30,000.00	1	30,000	
33.01.90	Prepare remedial action work plan	lump sum	35,000.00	1	35,000	
33.01.91	Prepare and evaluate bid	lump sum	50,000.00	1	50,000	
33.01.92	Permitting	lump sum	10,000.00	1	10,000	
	WBS Subtotal					**$125,000**
17	**Site Preparation**					
17.01	Site clearing					
17.01.0101	Clear light brush without grub	acre	44.54	6	267	
	WBS Subtotal					**$267**
33.02	**Monitoring, Sampling, Testing, and Analysis**					
33.02	Confirmational sampling -1 per 10,000-square-foot grid					
33.02.0222	Screen for radioactivity	sample	123.69	300	37,107	
33.02.02357	Characterize unknown radioactive sample	sample	2,473.56	30	74,207	
[illegible]02.1714	Soil lab analysis - BTEX	sample	123.69	100	12,369	
33.02.1717	Soil lab analysis - PCBs	sample	213.96	100	21,396	
33.02.1722	Soil lab analysis - PAHs	sample	298.37	100	29,837	
33.02.1760	Soil lab analysis - metals, EA (8)	sample	148.41	100	14,841	
	WBS Subtotal					**$189,757**
17.03.02	**Common Excavation and Disposal**					
17.03.0219	3.73 CY track loader	hour	108.77	168	18,273	
17.03.0246	Scraper, 34 CY with D9 bulldozers	hour	283.47	168	47,623	
17.03.0423	Backfill, unclassified fill, 6-inch lift, off site	CY	7.15	6,050	43,258	
	WBS Subtotal					**$109,154**
33.18	**Disposal (Other than Commercial)**					
33	Radium Dial and Waste Segregation					
33.18.8401	41.5-foot automatic conveyor	EA	5,601.93	1	5,602	
33.18.8603	6-by-20-foot triple-tray vibrating screen	EA	42,193.45	1	42,193	
	WBS Subtotal					**$47,795**
33.19	**Disposal (Commercial)**					
33.19.0283	Radioactive truck haul 500+ miles roundtrip and 303 truck (20 CY) loads	mile	4.88	182,400	890,112	
33.19.0210	Transportation 300 to 399 miles roundtrip and 23,560 truck (20 CY) loads	mile	3.28	49,400	162,032	
33.19.0311	Truck washout	truck	185.51	304	56,395	
33.19.0317	Waste stream evaluation fee	EA	494.71	30	14,841	
33.19.7263	Landfill hazardous solid bulk waste disposal	ton	166.97	4,084	681,905	
33.19.90	Radioactive waste disposal	CY	2,025.00	3,025	6,125,625	
	WBS Subtotal					**$7,930,911**

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TABLE A-3

COST OPINION AND ASSUMPTIONS
REMEDIAL ACTION ALTERNATIVE 3
EXCAVATION OF RADIOACTIVE MATERIAL, SEGREGATION OF RADIUM DIALS, OFF-SITE TREATMENT AND DISPOSAL
PARCEL E - SITES IR-01/21, IR-02, AND IR-03
HUNTERS POINT ANNEX

WBS Code	Item/Description	Unit	Unit Cost ($)	Quantity	Subtotal ($)	Total ($)
33.21	**Demobilization**					
33.21.04	Demobilize equipment	lump sum	20,000.00	1	20,000	
33.21.06	Prepare removal action report	lump sum	30,000.00	1	30,000	
	WBS Subtotal					**$50,000**
	Total Direct Costs					**$8,452,884**
	Contingency (20% of direct costs)	(20%)				**$1,690,577**
	Project administration (10% of direct costs)	(10%)				**$845,288**
TOTAL COST ESTIMATE						**$10,988,749**

Notes:

Unit costs for all labor, equipment, and material costs
Unit costs obtained from the ECHOS Environmental Restoration: Unit Cost Book and from vendor price quotes
Radioactive waste disposal at Envirocare Radioactive Waste Disposal Facility in Clive, Utah
Hazardous waste disposal at Chemical Waste Management Class I Landfill in Kettleman Hills, California
A 25 percent discount factor applied to disposal unit costs due to large waste disposal volumes and economies of scale

CY	Cubic yard
BTEX	Benzene, toluene, ethylbenzene, and xylenes
EA	Each
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
TCLP	Toxic characteristic leachate procedure