8. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

As expressed in 40 CFR §300.430(a)(1)(i), the goal of the remedy selection process under CERCLA is to develop and implement remedial actions that protect human health and the environment, maintain protection over time, and minimize untreated waste. Identifying and screening potentially suitable technologies is the initial step in assembling appropriate remedies. Technologies that pass the screening process are developed into remedial alternatives. The remedial alternatives are themselves screened and the alternatives that are retained undergo detailed analysis. The results of the detailed analysis determine the remedial alternatives that are recommended for implementation. Section 8 describes the identification and screening of technologies. Section 9 summarizes the development and screening of remedial alternatives. Section 10 presents the detailed analysis of alternatives.

8.1 PRINCIPAL THREAT AND LOW-LEVEL THREAT WASTES

To facilitate the identification and screening of technologies, U.S. EPA (1991b) has developed guidelines to communicate the types of remedies it generally anticipates to find appropriate for different source materials. U.S. EPA (1997e) defines source material as the following:

> …material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, to surface water, to air, or acts as a source for direct exposure.

Source material is divided into principal threat wastes and low-level threat wastes. The definitions of these wastes are as follows:

- **Principal Threat Wastes:** Source materials that are considered to be highly toxic or extremely mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. Principal threat wastes include non-aqueous phase liquids ("NAPLs"), extremely mobile liquids (e.g., solvents), or materials having high concentrations of toxic compounds. Although no "threshold level" of toxicity has been established for definition of a principal threat waste, U.S. EPA (1991b) indicates for conditions where toxicity and mobility of source material combine to pose a potential risk of 10^{-3} or greater, treatment alternatives generally should be evaluated.

- **Low-level Threat Wastes:** Source materials that can be reliably contained and that would pose only a low risk in the event of exposure. Low-level threat wastes are source materials that exhibit low toxicity, limited mobility in the environment, or have COC concentrations near health-based levels.

As discussed in Section 6, Main Installation sites include landfills that contain soil or municipal waste (e.g., garbage, household refuse, yard clippings, landscaping wastes, construction debris), and miscellaneous sites where the predominant COCs are metals and PAHs in soil that are generally present at concentrations only slightly greater than applicable cleanup levels. Consequently, source materials at Main Installation sites can be characterized as low-level threat wastes.

8.2 PRESUMPTIVE REMEDIES

U.S. EPA has established presumptive remedies that apply to both landfills and sites that have metals in soil that constitute low-level threat wastes. Presumptive remedies are preferred response actions or technologies for sites with similar characteristics. U.S. EPA identifies presumptive remedies based upon information acquired from evaluating and cleaning up sites under Superfund. A primary reason for U.S. EPA establishing presumptive remedies is to streamline remedy selection by narrowing the universe of technologies and alternatives that must be considered in an FS. U.S. EPA (1993b) also believes that presumptive remedies will produce the added benefit of promoting consistency in remedy selection and improving the predictability of the remedy selection process for communities and potentially responsible parties. A simpler and less technical discussion of presumptive remedies can be found in U.S. EPA's (1997d) *A Citizen's Guide to Understanding Presumptive Remedies*.

The NCP at 40 CFR §300.430(a)(1)(iii)(B) states that "U.S. EPA expects to use engineering controls, such as containment, for wastes that pose a relatively low long-term threat or where treatment is impracticable." Accordingly, the presumptive remedy for both landfills and soil with metals that pose a low-level threat is containment achieved through use of capping technologies, such as permeable or low-permeability covers (U.S. EPA, 1999b, 1996b, 1993c). Although the containment presumptive remedy applies to source material found at Main Installation sites, the Trust has elected not to universally accept this remedy for implementation. The Trust is aware that the cultural and natural resources of the Presidio make it one of the most visited national parks in the United States, resulting in varied recreational, commercial, and residential uses. Site-specific conditions must be taken into account when evaluating the suitability of remedial alternatives. The Trust has therefore decided it is necessary, as part of this Presidio Trust Revised FS Report, to develop a range of remedial alternatives and determine the compatibility of these potential remedies with the current and planned land uses of areas where Main Installation sites are found.

8.3 IDENTIFICATION AND SCREENING OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS

Table 8-1 summarizes the screening of general response actions, technologies, and process options for affected soil and sediment at Main Installation sites. Table 8-2 summarizes the screening of general response actions, technologies, and process options

for affected groundwater and surface water at Main Installation sites. Potential approaches for addressing soil, sediment, groundwater, and surface water are organized by general response actions. U.S. EPA (1988a) considers general response actions to be those actions that will satisfy RAOs introduced in Section 5 of this report.

General response actions are divided into remedial technologies, which themselves are divided into process options. Remedial technologies refer to general categories of technologies, such as capping, subsurface barriers, or extraction. Process options refer to specific processes within each category of remedial technology. For example, extraction remedial technology would include the process options of using wells or trenches to remove groundwater from the subsurface. As indicated in Tables 8-1 and 8-2, several broad types of remedial technologies may be identified for each general response action, and numerous process options may exist for each category of remedial technology.

In accordance with U.S. EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*, EKI has eliminated those general response actions, remedial technologies, and process options that do not achieve the criterion of technical implementability. The physical conditions, and types and concentrations of COCs at Main Installation sites were reviewed to determine which approaches cannot be effectively implemented at the Presidio. The results of screening for general response actions, remedial technologies, and process options are discussed in Sections 8.3.1 through 8.3.10.

8.3.1 No Action

The NCP at 40 CFR §300.430(e)(6) requires that the "no action" alternative be evaluated as a baseline for comparison of other alternatives developed. The no action alternative may be appropriate for selection under certain circumstances. U.S. EPA (1991g) states the following regarding the need to implement remedial actions at a site:

> If the baseline risk assessment and the comparison of exposure concentrations to chemical-specific standards indicates that there is no unacceptable risk to human health or the environment and that no remedial action is warranted, then the CERCLA Section 121 cleanup standards for selection of a Superfund remedy, including the requirement to meet applicable or relevant and appropriate requirements (ARARs), are not triggered.

The no action alternative is viable for Main Installation sites where COCs in soil and water are less than applicable cleanup levels, which are specified in Section 5. This general response action is **retained** for further consideration.

8.3.2 Institutional Controls

Institutional controls (e.g., Land Use Controls ("LUCs")) are non-engineering measures designed to limit exposure to hazardous substances left in-place or to ensure the

effectiveness of the chosen remedy. Institutional controls that may be applicable to the Presidio sites are discussed in this section. The Consent Agreement between the DTSC, Trust, and NPS indicates that the Trust will include "a conceptual monitoring plan, institutional controls, and operations and maintenance plan in the evaluation of alternatives…" (DTSC, 1999a). Land use controls are discussed in Section 8.3.2.1. Monitoring is discussed in Section 8.3.2.2. Operations and maintenance plans may be appropriate for remedial alternatives that include ongoing care and operation, such as care of cover systems or groundwater extraction and treatment systems.

8.3.2.1 Land Use Controls

Land use controls can also be referred to as deed restrictions. Although the term deed restrictions commonly appears in RODs, consent decrees, and even the NCP, it is not a traditional real property term and does not have a precise legal meaning (U.S. EPA, 1999d). Deed restrictions and land use controls are catchall phrases for legal controls such as easements, restrictive covenants, and zoning ordinances. These controls either prohibit certain kinds of site uses or notify potential owners or tenants of the presence of hazardous substances remaining on-site at concentrations that are not protective of all uses. Institutional controls, including land use controls, are important components of remedial alternatives that will leave wastes or COCs above applicable cleanup levels in soil or water. For such alternatives, U.S. EPA (1995e) states the following:

> If any remedial alternative developed during the FS will require a restricted land use in order to be protective, it is essential that the alternative include components that will ensure that it remain protective. In particular, institutional controls will generally have to be included in the alternative to prevent an unanticipated change in land use that could result in unacceptable exposures to residual contamination, or, at a minimum, alert future users to the residual risks and monitor for any change in site use.

U.S. EPA and DTSC (DTSC, 2002) expect that land use controls typically will be used in conjunction with engineering controls. This expectation is made clear in the NCP. At 40 CFR §300.430(a)(1)(iii)(D), U.S. EPA states the following:

> The use of institutional controls shall not substitute for active response measures (e.g., treatment and/or containment of source material, restoration of ground waters to their beneficial uses) as the sole remedy unless such active measures are determined not be practicable, based on the balancing of trade-offs among alternatives that is conducted during the selection of the remedy.

At the Presidio, legal controls, such as deed restrictions or covenants, cannot be put in place. The Trust's PTMP (Trust, 2002) and the NPS' GMPA (NPS, 1994) effectively act as zoning ordinances for land use at the Presidio. These plans, in conjunction with a

Presidio-wide Land Use Controls Master Reference Report ("LUCMRR") and Site-specific addenda to the LUCMRR, will be used to enforce land use controls or Land Use Covenants as defined by DTSC.

Land use controls, the primary institutional control that may be used at the Presidio, will be implemented by the Trust and NPS through their planning and project review programs[24] and with a Presidio-wide LUCMRR. Existing and planned land uses at the Presidio are guided by requirements set forth in the GMPA (NPS, 1994) (for Area A) and the PTMP (Trust, 2002) (for Area B). In effect, the GMPA and the PTMP are "zoning" documents that establish the designated land uses and associated applicable cleanup levels throughout the Presidio (see Figures 5-3 and 5-4). Notwithstanding the GMPA and the PTMP, the Trust will prepare a Presidio-wide LUCMRR that will establish protocols for the general implementation and Presidio-wide enforcement of land use controls.

For sites where impacted material is being managed in place (e.g., covering of a landfill) or sites which are not cleaned up to residential land use cleanup levels, land use controls will be implemented to restrict certain uses at the site. The types of LUC to be implemented at a given Site will be described in the RAP for that Site. In addition, a site-specific addendum to the LUCMRR will be prepared to supplement the Presidio-wide LUCMRR[25]. These site-specific addenda will include a figure depicting the site location and area and will summarize the specific COCs encountered at a site, the actions taken to remediate the site, and the in-place management system or the levels of COCs remaining at the site that required the implementation of land use controls. In addition, these site-specific addenda will discuss unallowed land uses at the site and any special requirements if residual chemicals or wastes are left in place in an inaccessible area (e.g., health and safety requirements if the area is disturbed in the future).

The Trust generally does not consider land use controls by themselves to be appropriate remedies for Main Installation sites where source materials may remain in-place. However, as discussed in Section 8.3.2.2, land use controls in combination with monitoring may be suitable for sites where no source material exists in soil or sediment, and COCs in groundwater or surface water are therefore likely to decrease due to natural attenuation. Institutional controls, including land use controls, may be implemented at sites in conjunction with engineering controls (such as covers) that are used to create a physical barrier between potentially exposed populations and wastes or COCs above applicable cleanup levels in soil or groundwater. In addition, land use controls may be appropriate for sites where remedial actions achieve the cleanup levels for the land use

[24] The Trust and NPS' land use compliance process (i.e., project review programs) is a first step to insure that Trust and NPS staff are aware of known contamination in the vicinity of project sites with land use controls. The Trust's N^2 process and the NPS' Project Review and 5X processes are used for compliance with the National Environmental Protection Act ("NEPA"), the National Historic Preservation Act ("NHPA"), and other such regulations. Every project at the Presidio (e.g., fence post installation, tree trimming, native plant restoration, building renovation, and building demolition) is screened through N^2 if the project is in Area B and Project Review and 5X if it is in Area A. This review process can be used to alert Trust and NPS staff to known and remediated chemical release sites.

[25] The Trust intends to add each site-specific addendum as an attachment to the Presidio-wide LUCMRR. As such, the LUCMRR will effectively be a "working document", supplemented with additional information as it becomes available.

designation identified in the PTMP or GMPA, but may not achieve the more stringent residential cleanup level. Land use controls are **retained** for further consideration.

8.3.2.2 Monitoring

Monitoring is an important component of remedial actions that will leave wastes or COCs above applicable cleanup levels in soil or groundwater. For sites where land use controls will be imposed, monitoring is essential to confirm that land use controls are performing as intended. For example, if land use controls prohibit construction of potable supply wells, routine inspections must be performed to ensure that construction of such wells is not occurring. Similarly, if an engineered cover system is placed over a landfill, monitoring is needed to assess if digging beneath the cover is taking place and, if so, is it being conducted in such a manner that potential risk to human health and the environment is mitigated. U.S. EPA (2000f) states that the details concerning monitoring of land use controls should be included in the ROD or post-ROD documents, such as a Remedial Design, RAP, or Operation and Maintenance Plan.

Monitoring may also entail ongoing soil, sediment, air, biological, surface water, or groundwater sampling to assess the impacts of COCs on environmental conditions at Main Installation sites. Routine groundwater sampling, in particular, is anticipated to be a component of preferred remedial actions for several Main Installation sites, such as Fill Site 1, and Fill Site 6, where it is unclear if groundwater has been impacted by chemical releases. After addressing source materials in soil at these sites, groundwater sampling, or Monitored Natural Attenuation ("MNA"), may be an appropriate groundwater remedial action. U.S. EPA (1999e) defines MNA as the following:

> …the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The "natural attenuation processes" that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil and groundwater. These *in-situ* processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants.

U.S. EPA (1999e) stresses that source control and long-term performance monitoring will be fundamental components of any MNA remedy. The Trust believes that MNA will be an appropriate remedial action for Main Installation sites only where its use protects human health and the environment, and is capable of achieving RAOs within a time frame that is reasonable compared to other alternatives. Monitoring is **retained** for further consideration.

8.3.2.3 Alternate Water Supply

Surface water flow in Lobos Creek has provided most of the potable supply at the Presidio. The GMPA anticipates that potable supply will come primarily from Presidio sources but that reliance on surface water in the future will be reduced in favor of increased use of groundwater. The reasons for this change are that groundwater is less intensive to treat than surface water and the Lobos Creek ecosystem might benefit if surface water is not diverted.

Instead of extracting groundwater from the Presidio, another possible approach for reducing reliance on surface water from Lobos Creek is to connect to the City of San Francisco potable supply system. However, this approach conflicts with sustainability of the Presidio as called for in the GMPA. Further, the City of San Francisco may not have adequate capacity to provide water to the Presidio. In its review of the Army's Environmental Impact Statement ("EIS") regarding closure of the Presidio as a military base, the San Francisco Water Department (1990) made the following comment:

> The statement made in the [EIS] report that "the City could supply 100% of the Presidio's present [potable water] requirements if necessary" (Page 3-23) is extremely misleading. First, in the current drought situation, the City is finding it difficult to meet the water demands of its current customers, and is in fact considering the Presidio as a possible emergency resource. Second, the San Francisco Water Department is facing a long-term problem of escalating water demand in relation to its supply. As a result, the San Francisco Water Department is currently attempting to stretch this supply by increasing use of local groundwater. It is a matter of great concern for this report to imply that Presidio groundwater is an optional water source that can be readily replaced. In reality, it is a water source that is needed and should be developed further if possible.

The use of an alternate water supply is **not retained** for further consideration.

8.3.3 Containment

Containment refers to the use of capping technologies or engineered cover systems to minimize contact of wastes and COCs in soil by humans and ecological receptors. Depending upon the properties of wastes and COCs in soil being contained, the cover system may have to be designed to reduce surface water infiltration, control gas and odor emissions, provide stability, and improve aesthetics. Regardless of the type of cover system selected, land use controls and ongoing maintenance activities are likely to be included as part of the containment remedy to ensure its long-term protectiveness. An Operation and Maintenance Plan that specifies inspection frequencies, repair methods, and other protocol to protect the cover will be developed as a component of the final remedial design.

Containment is the presumptive remedy for both landfills containing municipal wastes and sites with metals in soil that pose a low-level threat (U.S. EPA, 1999b, 1993c). Containment has been used extensively at landfills remediated under Superfund. For example, U.S. EPA's (1996b) review of 41 landfills at military installations for which remedial actions were chosen, containment was implemented at 23 of the landfills. In addition, the review found that the area of a landfill influenced remedy selection. Of the 27landfills greater than one acre in size, containment was selected at 23 of these landfills. Of the 14 landfills with an area of one acre or less, containment was not selected. Most of the Presidio landfills are greater than one acre in size. The EPA's review focuses primarily on area for containment. Although no set excavation volume limit is set, EPA states that landfills with volumes greater than 100,000 cubic yards would not normally be considered for excavation, implying that containment may be more appropriate for such large volumes of wastes (U.S. EPA, 1996b).

Containment remedies implemented at landfills and other sites are often compatible with anticipated future uses of these areas. Landfills have been transformed into wildlife enhancement areas, recreational facilities, and commercial developments. U.S. EPA (1999c) observes that former municipal landfills are a natural fit for recreational uses because "they typically have a large surface area and the cap can be contoured to meet the specifications for ball fields or golf courses."

8.3.3.1 Permeable Cover Systems

Permeable cover systems are not designed to restrict the infiltration of surface water. Permeable covers may consist of clean soil, or asphalt, concrete walk-ways, and building slabs if the GMPA or PTMP allows for construction of improvements at areas where Main Installation sites are located. Use of permeable covers is appropriate for landfills and miscellaneous sites where no impacts to groundwater have been observed or are anticipated. A detail of a permeable cover is depicted on Figure 8-1. Permeable covers are **retained** for further consideration.

8.3.3.2 Low-Permeability Cover Systems

Low-permeability cover systems are designed to promote surface water drainage away from the cap and to minimize infiltration of water into the soil or waste containing COCs. Low-permeability covers include monolithic soil covers and geosynthetic covers.

8.3.3.2.1 Monolithic Soil Cover

A monolithic soil cover consists of a three- to five-foot thick layer of silty sand or sandy silt designed to remove water through a combination of run-off and enhanced evapotranspiration. In areas with moderately low rainfall, these cover systems can be effective to minimize infiltration. Potential advantages of a monolithic soil cover include ease of constructing a single layer, cost savings if there is a nearby suitable borrow source, and the ability to construct the cover on relatively steep slopes; that is, for every two feet in the horizontal direction, the slope falls about one foot in the vertical direction

("2H:1V"). However, conditions at the Presidio are not ideal for widespread application of monolithic soil covers for these reasons:

- The annual average rainfall at the Presidio is approximately 20 inches per year, with annual precipitation amounts exceeding 30 inches having been recorded. Monolithic soil covers are generally most effective in areas with annual precipitation of less than 20 inches.

- Frequent fog and relatively cool coastal temperatures limit evapotranspiration rates at the Presidio.

- A suitable soil borrow source is not likely available nearby, unless soil can be segregated during the excavation of other Main Installation landfills and reused as cover material.

Use of a monolithic soil cover is **not retained** for further consideration in recognition of the reasons above.

8.3.3.2.2 Geosynthetic Cover

At sites where the cost to import soil is high, portions of engineered cover systems may be constructed with geosynthetic materials instead of soil. Examples include using a geomembrane in place of a clay barrier and a geotextile as a substitute for a sand drainage layer. A geosynthetic cover is a multi-layer cap system. A low-permeability geomembrane is typically placed over a foundation layer, such as compacted soil or aggregate, to restrict infiltration of surface water into the landfill or soil containing COCs. A drainage layer consisting of geotextile is installed over the geomembrane to facilitate removal of infiltrated surface water that accumulates on top of the geomembrane. Clean soil and vegetation are placed over the drainage layer to protect it from damage, and contact by humans and ecological receptors. A detail of a geosynthetic cover system is depicted on Figure 8-1.

Geomembranes can be constructed of high density polyethylene ("HDPE"), linear low density polyethylene ("LLDPE"), or polypropylene. HDPE is a recognized waste-compatible material and is widely accepted by regulatory agencies. However, in certain cover applications, LLDPE and polypropylene may be advantageous due to their ability to accommodate larger strains induced by settlement.

Gas may sometimes be generated within a landfill. Generation of gas typically results from biological decomposition of organic materials in the landfill. The rate and process of gas generation are dependent upon the availability of moisture, temperature, and the organic content, particle size, and compaction of the deposited wastes (U.S. EPA, 1995d). If methane, hydrogen sulfide, VOCs, or other gases produced within the landfill must be managed, then it may be necessary to install a gas collection layer underneath the low-permeability geomembrane or place vent wells in the landfill.

According to U.S. EPA (1991c), the essential component of a gas venting system is a gravel-packed trench or a series of wells. A vacuum may be applied to the venting system (i.e., active venting) or the system may be simply open to the atmosphere (i.e., passive venting). Active venting systems are used to recover gases migrating from a landfill through unsaturated soil. A passive venting system may be used to liberate gases from a landfill that are lighter than air (e.g., methane), which creates a driving force from the landfill to the atmosphere.

A geosynthetic cover is appropriate for Main Installation landfills containing municipal wastes and would achieve final cover requirements specified in 27 CCR §21090 for such units. Use of a geosynthetic cover is **retained** for further consideration.

8.3.4 In-situ Soil Treatment

In-situ soil treatment consists of remedial technologies that destroy COCs or reduce their toxicity or mobility without first having to excavate the wastes or affected soil. Soil is treated in-place. In-situ soil treatment consists of physical/chemical, thermal, and biological remedial technologies.

8.3.4.1 <u>In-situ Soil Treatment Using Physical/Chemical Technology</u>

Soil flushing, immobilization, soil vapor extraction, and electrokinetics are the process options considered in this Presidio Trust Revised FS Report that use physical/chemical technology for in-situ treatment of soil.

8.3.4.1.1 Soil Flushing

Soil flushing involves injecting an aqueous solution to remove COCs from the subsurface without first having to excavate the wastes or affected soil. COCs are liberated from or transformed in soil if they are soluble, create an emulsion, or react with the solution injected into the subsurface. After passing through the affected soil, the aqueous solution is collected by strategically placed wells, and brought to the surface for disposal, recirculation, or on-site treatment and reinjection.

Complete recovery of the aqueous solution used to wash soil is extremely difficult. Substantial amounts of wastewater and slurry may be generated to remove COCs that are present in soil at relatively low concentrations. These residuals require treatment and disposal. Further, soil flushing is an emerging technology that has not been extensively applied to remove inorganic compounds such as metals from soil. Most soil flushing applications involve remediation of VOCs on a bench or pilot scale (Smith, et al, 1995). Under the NCP at 40 CFR §300.430(a)(1)(iii)(E), innovative technologies are to be considered as potential remedial actions when such technologies offer:

> …the potential for comparable or superior treatment performance or implementability, fewer or less adverse impacts than other available

approaches, or lower costs for similar levels of performance than demonstrated technologies.

Soil flushing is an emerging physical/chemical process. Soil flushing is **not retained** for further consideration because other suitable and more reliable processes exist for removing or treating COCs detected in soil at Main Installation sites.

8.3.4.1.2 Immobilization

Immobilization refers to mixing chemical reagents with wastes or COC-containing soil to change the toxicity, or physical or leaching characteristics of these materials through solidification and stabilization processes. Solidification entails physically locking COCs within a solidified matrix in the form of a crumbly soil-like mixture or a monolithic block. Stabilization converts COCs to a more immobile form, typically by chemical reaction. Immobilization is a presumptive remedy for soil with metals that pose a principal threat (U.S. EPA, 1999b).

A significant challenge for successfully accomplishing immobilization in-situ is uniform mixing of chemical reagents with the impacted soil (U.S. EPA, 1991c). Approaches used for in-situ mixing of chemical reagents include in-place mixing by conventional earth-moving equipment such as backhoes, draglines, or clamshell buckets, and injection grouting or vertical auger mixing. Injection grouting involves forcing a solution containing dissolved or suspended reagents under pressure into the subsurface. In vertical auger mixing, a system of augers is used to inject and mix reagents into the soil. Crane-mounted vertical augers loosen the soil and mix in reagents. In-situ immobilization with conventional earth-moving equipment is limited to near surface soil. Both shallow (10 to 20 feet bgs) and deep (up to 150 feet bgs) immobilization can be accomplished by vertical auger mixing, which is adapted from the construction industry (Smith, et al, 1995).

Verifying satisfactory mixing of reagents in the subsurface is often difficult. Wastes and debris, or soil having high clay content impedes in-situ immobilization. Consequently, this process is not likely to be applicable to Main Installation landfills because of the nature of deposited wastes (e.g., concrete, landscaping wastes, household refuse), and its effectiveness may be difficult to judge at miscellaneous sites. In-situ immobilization is **not retained** for further consideration.

8.3.4.1.3 Soil Vapor Extraction

Soil vapor extraction ("SVE") is a process for removing VOCs from unsaturated soil. SVE generally does not address non-volatile chemicals, such as metals. SVE requires installing one or more vertical or horizontal extraction wells in the affected soil. A vacuum is applied to the wells to induce air flow through the soil and into the SVE well. VOCs volatilize as air moves through the soil. VOC-laden air is captured by the SVE extraction wells for off-gas treatment. Common off-gas treatment systems include granular activated carbon ("GAC") adsorption, and thermal or catalytic oxidation.

For sites with a mixture of VOCs and non-volatile contaminants, U.S. EPA (1996e) states that SVE should be considered only if it can be used in combination with other remedies. SVE is **not retained** for further consideration because VOCs are only infrequently detected and the predominant COCs at Main Installation sites are metals.

8.3.4.1.4 Electrokinetics

Electrokinetics removes metals and other COCs from soil and groundwater by applying an electric field in the subsurface. The process works by using a charged electric field to induce movement of ions, particulates, and water through soil (Hinchee et al, 1989). The electric field is applied through anodes and cathodes placed in the soil. Most metals form positively charged ions that migrate towards the negatively charged electrode, or cathode.

A conductive solution must be injected into unsaturated soil to act as a carrier for metals to the cathodes. Like soil flushing, this conductive solution must be recovered for treatment. For this reason, electrokinetics is most applicable to saturated soil with nearly static groundwater flow and moderate to low permeability. A low groundwater flow rate is required so that ionic diffusion rather than advective flow is the main transport mechanism. Water is required to provide a polar medium for flow of metal ions. Electrokinetics is less dependent on high soil permeability than soil flushing because electrokinetic separation occurs due to ionic migration rather than bulk fluid flow. Fine-grained soil, such as clay and silt, are reported to be an ideal medium for electrokinetics (U.S. EPA, 1992a). Heterogeneities or anomalies found at sites, such as building foundations, rubble, significant quantities of iron or iron oxides, large rocks, or gravel may reduce the efficiency of metal removal (Acar et al, 1995).

Electrokinetics is still in the development phase. Electrokinetics is **not retained** for further consideration because other suitable and more reliable processes exist for removing or treating COCs detected in soil at Main Installation sites.

8.3.4.2 <u>In-situ Soil Treatment Using Thermal Technology</u>

Vitrification is the only process option considered in this Presidio Trust Revised FS Report that uses thermal technology for in-situ treatment of soil.[26] Vitrification converts affected soil into a stable glass or crystalline monolith. Vitrification is based on electric melter technology, and the principle of operation is joule heating, which occurs when an electrical current is passed through a region that behaves like a resistive element. Electric current is applied through an array of electrodes inserted vertically into the zone of affected soil. Because dry soil is not conductive, flaked graphite and glass frit is placed in a small trench between the electrodes to act as the starter path for the flow of electricity. Electricity in the starter path transfers heat that melts the soil. The soil becomes conductive once molten. The melt grows outward and downward as electricity

[26] Although there are other in-situ thermal treatment technologies, those technologies primarily focus on the remediation of VOCS. Therefore, other in-situ thermal treatment technologies are not considered appropriate for use at the Presidio because VOCs are not predominant COCs at the Presidio.

is continually applied. Smith et al (1995) reports that soil has been treated to a maximum depth of approximately 20 feet bgs with this process.

Availability of equipment limits implementability of vitrification (U.S. EPA, 1999b). In addition, the process is expensive to implement with costs highly dependent upon local energy rates, and the characteristics of deposited wastes and soils with COCs. For these reasons, vitrification is **not retained** for further consideration.

8.3.4.3 In-situ Soil Treatment Using Biological Technology

Phytoremediation and bioremediation are the process options considered in this Presidio Trust Revised FS Report that use biological technology for in-situ treatment of soil.

8.3.4.3.1 Phytoremediation

Phytoremediation involves growing plants in wastes or soil. Plants established in the impacted soil uptake COCs and incorporate the chemicals in their plant structures. Plants that have accumulated the COCs in their biomass are subsequently harvested for disposal at an off-site, permitted waste management facility. The most important limitation to phytoremediation is rooting depth, which can be 0.5, 1, or 3 feet bgs, depending on the plant and soil type. Therefore, one of the favorable site conditions for phytoremediation is that metal contamination be restricted to surface soil (U.S. EPA, 1997k).

Lead, which is present at numerous Main Installation sites, is difficult for plants to uptake (U.S. EPA, 1997k). This fact was borne out by the Army when it conducted a treatability study at the Building 950 Area to determine if phytoremediation would be effective in removing lead from soil. Based on the results of the treatability study, the Army (1997a) concluded that phytoremediation is "not a viable alternative for the soils at the Presidio." Rather than implementing phytoremediation, the Army excavated lead-containing soil at the Building 950 Area, and transported and disposed of the soil at an off-site, permitted waste management facility.

Phytoremediation is **not retained** for further consideration given that the treatability study conducted by the Army found that the process is not effective for soil at the Building 950 Area. Other suitable and more reliable processes exist for removing or treating COCs detected in soil at Main Installation sites.

8.3.4.3.2 Bioremediation

Bioremediation involves stimulating indigenous microorganisms, such as bacteria and fungi, to transform hazardous chemicals to less toxic or non-toxic chemicals. Oxygen, water, and nutrients are supplied to wastes or soil to promote biological transformation of petroleum hydrocarbons or other organic chemicals under aerobic (i.e., presence of oxygen) conditions. Bioremediation of COCs, such as chlorinated organic solvents, may also occur under anaerobic (i.e., lack of oxygen) conditions. The applicability of bioremediation depends on the biodegradability of COCs at a site. Petroleum

hydrocarbons, such as gasoline and diesel fuel, are known to be readily biodegradable. Other biodegradable COCs include alcohols, phenols, esters, and ketones. Chlorinated organic solvents become more difficult to biodegrade as the number of chlorine molecules increases (U.S. EPA, 1991c).

However, COCs at Main Installation sites are predominantly metals. According to Smith et al (1995), "the characteristics of biological alternatives for metal treatment generally are unfavorable for broad application to waste treatment. The biological treatment systems typically operate at slower rates than do the analogous chemical mechanisms." For this reason, bioremediation is **not retained** for further consideration.

8.3.5 Ex-situ Soil Treatment

Ex-situ soil treatment requires that wastes or soil with COCs be excavated before remedial technologies that destroy COCs, or reduce their toxicity or mobility are employed. Soil is treated aboveground. Ex-situ soil treatment consists of physical/chemical, thermal, and biological remedial technologies.

8.3.5.1 Ex-situ Soil Treatment Using Physical/Chemical Technology

Soil washing and immobilization are the process options considered in this Presidio Trust Revised FS Report that use physical/chemical technology for ex-situ treatment of soil.

8.3.5.1.1 Soil Washing

Soil washing is sometimes referred to as hydrometallurgical separation. Soil washing is a presumptive remedy for soil with metals that pose a principal threat (U.S. EPA, 1999b). The process requires intimate contact of metal-containing soil with the extraction solution. The presence of large clumps or debris interferes with good contact, so pretreatment to exclude or crush oversize material normally is required. The extraction solution is routinely treated during soil washing to remove accumulated metals. Reuse of the solution is required because the leaching chemicals in the solution tend to be expensive and the disposal cost would be prohibitive if the volume of waste extraction solution was not reduced through recycling (Smith et al, 1995).

Extraction solutions used in soil washing are specific to a limited range of metal species. Thus, most extraction solutions are effective only for a narrow range of metal and soil type combinations (U.S. EPA, 1999b). The extraction solutions may also have toxic characteristics. Soil washing is **not retained** for further consideration given these difficulties and the fact that metal concentrations in soil are relatively low at Main Installation sites with a few notable exceptions in particular soil samples. Other suitable and more reliable processes exist for removing or treating COCs detected in soil.

8.3.5.1.2 Immobilization

Because vigorous mixing is needed to disperse solidification or stabilization chemical reagents with affected soil, immobilization is often performed aboveground. Immobilization, which is described in Section 8.3.4.1.2, refers to processes that change the toxicity, or physical or leaching characteristics of COCs in soil by mixing chemical reagents with impacted soil.

Pretreatment is generally performed to separate and crush oversize materials, such as rocks and debris, which can interfere with mixing of chemical reagents. Mixing can be accomplished by a variety of methods, including in-drum, in-plant, or area mixing. In-drum mixing is typically used for highly toxic or small volumes of wastes, and involves combining the reagents and wastes in a small (e.g., 55-gallon) drum. In-plant mixing may consist of either continuous or batch operations. Batch operations generally use a rotary drum mixer. A rotary drum mixer is a slightly inclined vessel, usually with internal baffles, that rotates to tumble and combine the contents. Continuous operations generally involve a pug mill. A pug mill has paddles attached to a horizontal rotating shaft to accomplish mixing. Area mixing entails placing layers of reagent and soil in a bermed location and combining the layers with a backhoe or other earth-moving equipment. Area mixing differs from in-situ immobilization using earth-moving equipment in that the affected soil is excavated and moved to a bermed location for treatment.

The effectiveness of immobilization to reduce the toxicity of metals is well demonstrated (U.S. EPA, 1999b, 1997k, 1993d). Economies of scale may be obtained by transporting excavated metal-containing soil from the landfills and miscellaneous sites to a central treatment location at the Presidio. After solidifying or stabilizing the metals in soil, the resulting material could be disposed at an off-site, permitted waste management facility or used to backfill excavations at Main Installation sites if a permeable cover system is constructed over the treated material to prevent contact by humans and ecological receptors. Ex-situ immobilization is **retained** for further consideration.

8.3.5.2 Ex-situ Soil Treatment Using Thermal Technology

Thermal desorption, vitrification, and incineration are the process options considered in this Presidio Trust Revised FS Report that use thermal technology for ex-situ treatment of soil.

8.3.5.2.1 Thermal Desorption

Thermal desorption is any of a number of processes that use either indirect or direct heat exchange to vaporize COCs from excavated soil. Air, combustion gas, or inert gas is used as the transfer medium for the volatilized COCs. Thermal desorption systems provide physical separation and are not designed to destroy COCs. Soil is typically heated to 200 to 1,000°F depending on the thermal desorption system selected. COCs in

the off-gas may be incinerated in an afterburner, adsorbed onto vapor-phase GAC, or recovered in condensation equipment.

Thermal desorption has been proven effective in treating VOCs and SVOCs. Although volatile metals may be removed by higher temperature thermal desorption systems, the process is generally not effective in separating inorganic compounds from affected soil (U.S. EPA, 1991f). Thermal desorption is **not retained** for further consideration because VOCs and SVOCs are only infrequently detected and the predominant COCs at Main Installation sites are metals.

8.3.5.2.2 Vitrification

Vitrification described in Section 8.3.4.2 can be performed ex-situ as well as in-situ. However, the availability of equipment limits implementability of vitrification (U.S. EPA, 1999b). The process is expensive to implement with costs highly dependent upon local energy rates, and the characteristics of deposited wastes and soils with COCs. For these reasons, vitrification is **not retained** for further consideration.

8.3.5.2.3 Incineration

Incineration involves burning wastes to destroy organic compounds. Incineration employs temperatures typically in the range of 1,500 to 3,000°F to convert organic compounds into water, carbon dioxide, and nitrogen oxides (Freeman, 1989). Depending upon the waste types to be destroyed, incinerators may consist of liquid-injection incinerators, rotary kilns, fluidized bed systems, hazardous waste boilers, or cement kilns. Metals are not destroyed by incineration. Metals either volatilize or remain in ash. Incineration is expensive because it is an energy-intensive process. Incineration is **not retained** for further consideration because of its high cost and inability to destroy metals.

8.3.5.3 Ex-situ Soil Treatment Using Biological Technology

Phytoremediation and bioremediation are the process options considered in this Presidio Trust Revised FS Report that use biological technology for in-situ treatment of soil.

8.3.5.3.1 Phytoremediation

Phytoremediation described in Section 8.3.4.3.1 can be performed on excavated soil that has been transferred to a bermed location to contain water used to irrigate the plants established in the affected soil. Phytoremediation is **not retained** for further consideration given that the treatability study conducted by the Army found that the process is not effective for soil at the Building 950 Area. Other suitable and more reliable processes exist for removing or treating COCs detected in soil at Main Installation sites.

8.3.5.3.2 Bioremediation

Bioremediation described in Section 8.3.4.3.2 can be performed ex-situ as well as in-situ. Bioremediation is **not retained** for further consideration because COCs at Main Installation sites are metals that are not readily removed by biological treatment.

8.3.6 Excavation

Excavation of soil and waste with COCs is a general response action often implemented at sites where releases of hazardous substances have occurred. Excavation is typically accomplished with earth-moving equipment, such as backhoes, bulldozers, and front loaders. Excavating and removing waste materials, waste residues, and contaminated subsoil, also known as clean closure, will eliminate potential long-term risks to humans and ecological receptors at Main Installation sites. Excavated materials can be directly transported and disposed of at an off-site, permitted waste management facility, or segregation and reuse of materials may first be performed in an effort to reduce the volumes of wastes and soil that must be land disposed off-site. Although no volume limit has been established for determining the practicality of excavation, U.S. EPA (1996b, 1993c) states that landfills and sites with "a content of 100,000 cubic yards (approximately two acres, 30 feet deep) would normally not be considered for excavation."

For purposes of discussion and cost estimating purposes in this FS, the ultimate disposition of excavated material is divided into distinct processes. However, the actual disposition of material will likely be a continuum of the range of segregate and reuse versus off-site disposal options. Section 8.3.6.2 provides a detailed discussion of the factors that may influence the ability to recycle and/or reuse excavated materials. For the implementation of any excavation process, the most appropriate disposal method will be implemented in the field (i.e., segregate and reuse or off-site disposal). For example, if soil and debris are planned to be segregated and recycled, and the screening process is deemed ineffective in the field (due to clogging, inability to remove debris, wet materials, or other field conditions), then off-site disposal of wastes will be considered implementation of the selected remedy; no remedy revision will be required.

8.3.6.1 <u>Disposal of Soil and Waste Off-site</u>

Off-site disposal of soil and waste entails directly transporting excavated material to a permitted waste management facility. Excavated soil and waste must be characterized to determine the type of waste management unit or facility that is permitted to accept the material for disposal. The State of California regulates three specific types of waste management units. These waste management units include Class I units that receive hazardous wastes, Class II units that receive designated wastes, and Class III units that receive non-hazardous solid wastes.

Disposal of hazardous wastes is regulated under Title 22 of the CCR. Hazardous wastes are those wastes that are listed to be hazardous or exhibit hazardous characteristics as

defined by DTSC or U.S. EPA under RCRA. Disposal of designated and non-hazardous solid wastes is regulated under Title 27 of the CCR. Designated wastes are non-hazardous wastes that contain soluble pollutants in concentrations that exceed applicable water quality objectives or could degrade waters of the state. As discussed in Section 7, non-hazardous solid wastes are defined under 27 CCR §20220 as the following:

> Nonhazardous solid waste means all putrescible and nonputrescible solid, semi-solid, and liquid wastes, including garbage, trash, refuse, paper, rubbish, ashes, industrial wastes, demolition and construction wastes, abandoned vehicles and parts thereof, discarded home and industrial appliances, manure, vegetable or animal solid and semi-solid wastes and other discarded waste (whether of solid or semi-solid consistency); provided that such wastes do not contain wastes which must be managed as hazardous wastes, or wastes which contain soluble pollutants in concentrations which exceed applicable water quality objectives, or could cause degradation of waters of the state (i.e., designated waste).

Investigations performed at the Main Installation landfills and miscellaneous sites suggest that most soil and waste with COCs meet the definition of non-hazardous solid wastes. Review of available analytical data and observations of landfill contents indicate that segregating recyclable materials could possibly reduce the volumes of non-hazardous solid wastes necessitating off-site land disposal. However, any offsite disposal will comply with federal Land Disposal Restrictions ("LDRs"), identified in Table 7-1. Treatment required prior to land disposal could include incineration, stabilization, or other technologies to meet LDRs. As the required treatment would be conducted at the off-site, permitted disposal facility, any technology required to comply with LDRs is included as off-site disposal. Disposal of wastes and soil off-site is **retained** for further consideration.

8.3.6.2 Segregation of Wastes and Soil

Recycling to lessen the volume of excavated material that must be disposed in a waste management unit at an off-site, permitted facility offers several potential benefits, such as:

- Production of usable materials for construction of engineered cover systems at other Main Installation sites, thereby lowering costs by minimizing the quantity of soil that must be imported, and reducing the environmental impact of obtaining material from a quarry or other borrow source.

- Reduction in the quantity of materials that must be disposed off-site, thereby lowering costs and conserving disposal capacity at waste management facilities.

- Generation of credits that public agencies may apply toward satisfaction of State of California mandated recycling goals.

Recycling of excavated materials applies primarily to the heterogeneous contents of Main Installation landfills. Recycling may take place at the Presidio or off-site. Factors influencing the decision to recycle materials include:

- Varying quantities of materials that can be recycled on-site and off-site;
- Production rates achievable;
- Possible noise, congestion, and odors that may result from recycling, along with mitigation measures; and
- Presence of potentially hazardous wastes and other materials, such as asbestos, medical waste, unexploded ordnance, and radioactive materials, that may require specialized handling.

In addition, factors influencing the decision to recycle materials on-site or off-site include:

- **Available working area to conduct recycling operations.** Operating space would likely be limited at the actual landfill being excavated. However, segregation or recycling could possibly be conducted in a central location at the Presidio. There are a few existing commercial segregation and recycling operations in the Bay Area that are designed to receive, segregate, and recycle mixed waste; these are often associated with a landfill or other disposal facility. Available capacity, excavation schedule, transportation, liability issues, and unit price for segregation and disposal would all be considered in the selection of an off-site facility.
- **Public impacts of the recycling process.** Recycling operations conducted at the Presidio could potentially generate noise, dust, and odors that may affect local residents, businesses, and park visitors, depending on the location of the operations. These impacts would be limited to the excavation areas at the Presidio for an off-site recycling operation that did not occur in a populated area.
- **Local truck traffic**. Presidio truck traffic could potentially be increased due to trucking material from an excavation to an on-site recycling area, and from the recycling area to the ultimate end use location. For the off-site recycling alternative, it is likely that the same number of truck trips would leave the excavation; however, these trucks would depart the Presidio. There would be no additional local truck traffic to handle processed materials.
- **Resalable product value.** On-site segregation and recycling could potentially result in significant cost savings over direct disposal, particularly if the recycled materials could be used at the Presidio or sold on the local construction exchange. An example is the segregation and recycling of concrete and asphalt as base rock

for construction or road improvements. Fixed costs for a contractor to mobilize a concrete crusher and other segregation and recycling equipment may need to be balanced by the resale value of the recycled materials recovered. The actual value of recycled materials, such as base rock, scrap metal, and non-hazardous soil, can vary significantly based on local market conditions.

- **Cost.** The costs of on-site segregation and recycling versus off-site operations would impact the selection as well. Competitive bids from both types of entities would provide information to assist in assessing the best alternative.

If this technology is selected as a component of a remedial alternative, but the field application is not practicable, off-site waste disposal as discussed in Section 8.3.6.1 may be implemented. Such a change will not be considered a change or revision of the selected remedy.

Potential reuse options are discussed in Sections 8.3.6.2.1 through 8.3.6.2.4.

8.3.6.2.1 Reuse of Soil at Presidio

Material excavated from a landfill can be screened to separate soil from wastes. Soil can comprise 30 to 40 percent of the total waste volume for older landfills. The usability of segregated soil depends significantly upon the chemical concentrations in the soil. If the soil is relatively clean, it may be usable as final soil cover, or as a foundation layer below a low-permeability cover system that is placed on another Main Installation landfill. If the soil contains chemicals at concentrations that prevent its reuse on another Main Installation site, the soil may be acceptable as daily cover at an off-site, permitted waste management facility. Reuse of soil at the Presidio is **retained** for further consideration.

8.3.6.2.2 Disposal of Soil as Daily Cover

Another potential option for excavated soil that has been segregated from wastes is to dispose of the soil as daily cover over a waste management unit at an off-site, permitted facility. Daily cover is defined in 27 CCR §20164 as cover material placed on the surface of the active face of a waste management unit at the end of each operating day to control disease vectors, fire, odors, blowing litter, and scavenging. By using segregated soil instead of clean soil for daily cover, a waste management facility can receive tax benefits because the segregated soil is considered recycled material. Available tax benefits to a facility can translate into acceptance of segregated soil at a reduced rate. For example, disposing of soil as a Class II waste may incur a disposal cost on the order of $60/ton. In comparison, disposing of soil as cover material can cost approximately $30/ton. Of course, the added expense of screening material, which can vary, must be included in determining the economics of recycling versus direct disposal. Disposal of soil as daily cover is **retained** for further consideration.

8.3.6.2.3 Segregation and Recycling of Wastes

After the greater portion of the soil is screened from wastes, it may be possible to segregate and recycle the resulting wastes. The economics of this additional effort will depend on the composition, condition, and volume of the wastes. Typically, a waste recycling program will involve a number of processing techniques to segregate and recover the following types of materials:

- **Wood and green wastes:** Wood can often be chipped into "hog fuel" and sold to cogeneration facilities. The sale of wood wastes typically offsets the processing and transportation costs. Green wastes recovered from a landfill can be hauled to a composting facility or disposed of as daily cover at an off-site, permitted waste management facility.

- **Metal:** Separated metals may have economic value at recycling facilities.

- **Concrete:** Separated concrete may be crushed at a recycling facility to produce usable aggregate products. Crushed concrete obtained from building demolition has become an economical source of aggregate products in the Bay Area.

Segregation and recycling of wastes is **retained** for further consideration.

8.3.6.2.4 Disposal of Wastes Off-site

After segregating soil and recyclable materials, it is anticipated that some fraction of wastes will remain that must be disposed of at an off-site, permitted waste management facility. Alternatively, it may be determined that the recyclable materials in the wastes are too small or too hard to recover. Under these circumstances, it may be more economical to dispose of the wastes off-site without attempting further recycling. This process option is **retained** for further consideration.

8.3.7 Groundwater Collection/Diversion

Most COCs in groundwater at Main Installation sites are metals. Metal concentrations in groundwater samples are either low or are above cleanup levels in so few monitoring wells at a site that the results do not suggest groundwater has been significantly impacted. Regardless of this fact, groundwater collection/diversion technologies have been screened to assess their implementability at Main Installation sites.

8.3.7.1 Subsurface Barriers

For Main Installation landfills where impacted soil and waste extend into the saturated zone, subsurface barriers might be employed to prevent groundwater from becoming contaminated by contact with these materials. Subsurface barriers, such as a slurry wall or sheet piling, are vertical structures installed into the subsurface to contain or redirect

groundwater flow. Subsurface barriers are often used in conjunction with capping technologies to minimize the amount of water that infiltrates through wastes in a landfill.

To be effective, a subsurface barrier must be completed or "keyed" into a continuous layer of clay deposits or competent bedrock. This layer must have sufficiently low permeability to prevent leakage underneath the barrier, it must have adequate thickness for an appropriate key (e.g., 2 to 3 feet), and it must be of moderate depth (50 to 70 feet bgs) or installation of the subsurface barrier may not be feasible (U.S. EPA, 1991c).

8.3.7.1.1 Slurry Wall

A slurry wall is constructed by excavating a narrow trench, typically 2 to 4 feet wide, and backfilling it with low-permeability material. As excavation proceeds, a bentonite-water mixture is temporarily placed in the trench to stabilize the trench walls, thereby preventing collapse. The bentonite-water mixture also permeates into the soil and creates a filter cake on the walls that seals the soil to prevent loss of the low-permeability slurry that will be used to permanently fill the trench.

Slurry walls are differentiated by the materials used to permanently fill the trench. If slurry of soil, bentonite, and water is employed, then the wall is known as a soil-bentonite slurry wall. In some cases, slurry of portland cement, bentonite, and water is employed. This type of wall is referred to as a cement-bentonite slurry wall. Cement-bentonite slurry walls are used at sites where there is inadequate space to place and mix soil with bentonite and water, or where increased wall strength may be necessary. Cement-bentonite slurry walls may also be used where the site topography makes it impractical to install a soil-bentonite slurry wall. Soil-bentonite slurry will flow if the trench is not within a few degrees of level. Cement-bentonite walls that harden quicker are better suited to irregular topography.

Creation of grout curtains is another process by which low-permeability materials are introduced into the subsurface. The grout is pressure injected into soil or rock. Grout types are divided into particulate grout, and chemical grout. Particulate grouts are fluids that consist of a suspension of cement, clay, bentonite, or a combination of these materials in water. Chemical grouts rely on polymerization reactions to form hardened gels. Chemical grouts include portland cement, cement-bentonite, silicate, and organic polymer mixtures.

Both slurry walls and grout curtains are feasible to implement because these subsurface barriers can be keyed into competent bedrock that is generally no deeper than 30 feet bgs at Main Installation landfills. However, grout curtains are seldom used for diverting groundwater flow. Slurry walls are less costly and have lower permeability than grout curtains. Grouting is best suited for sealing voids or fractures in bedrock (U.S. EPA, 1991c). Use of slurry walls is **retained** for further consideration.

8.3.7.1.2 Sheet Piling

Sheet piling can consist of interlocking steel, precast concrete, or wood sections. In most applications to divert groundwater flow, steel is employed because concrete is used only in a situation where great lateral resistance is required and wood is a poor barrier against groundwater flow. Steel sheet piling is installed by driving individual sections into the ground with single, double-action impact or vibratory pile drivers. One of the biggest drawbacks of sheet piling is that it is difficult to install in rocky soil. Damage to or deflection of the steel sections is likely to render sheet piling ineffective as a groundwater barrier. Further, it is difficult to use sheet piling for deep groundwater situations because of limitations in the depth that piling can be driven. The maximum depth to which sheet piling can be driven without damage to the interlocks between individual sections is approximately 40 feet bgs (U.S. EPA, 1991c).

Despite these drawbacks, sheet piling can often be installed quicker and at less expense than slurry walls. Depth limitations may not be encountered at the Presidio because Main Installation landfills generally do not extend beyond 30 feet bgs. Use of sheet piling is **retained** for further consideration.

8.3.7.2 Extraction

Extraction provides hydraulic containment of chemical-containing groundwater by altering the direction of groundwater flow through creation of a depression in the piezometric surface. Extracted groundwater containing COCs must be treated or otherwise managed. Possible ex-situ treatment and management approaches are described in Sections 8.3.9 and 8.3.10, respectively.

Although extraction and ex-situ treatment is a presumptive remedy for sites with contaminated groundwater, restoration of chemical-containing groundwater generally will not be possible unless the source of COCs has been addressed. U.S. EPA (1996c) states that "source control is a critical component for active restoration remedies (e.g., extraction and treatment and in-situ methods) as well as for natural attenuation."

The characteristics of the chemicals released and the hydrogeologic properties of the site govern the potential for restoring groundwater to cleanup levels defined by ARARs or risk-based levels (U.S. EPA, 1996c). Relevant chemical characteristics include its volatility, how strongly it sorbs to soil, its potential for natural attenuation, quantities in which it was released, and whether it has formed NAPL. Relevant hydrogeologic properties include the stratigraphy (e.g., degree of interbedded and discontinuous soil layers), types (e.g., sand or clay) and heterogeneity of soil present, saturated soil hydraulic conductivity, extent of vertical groundwater flow, and temporal variation in the rate of groundwater movement.

8.3.7.2.1 Wells

Although horizontal wells can be constructed for extraction of groundwater, vertical wells are almost exclusively used because of the relative ease and lower cost of construction. Vertical wells can be completed to essentially any depth and at any location that allows access for the drilling equipment. Vertical wells are strategically placed to contain and collect the groundwater with COCs. This process option is **retained** for further consideration.

8.3.7.2.2 Trenches

Trenches or drains may be used to collect groundwater. Drains are typically installed perpendicular to the direction of groundwater flow. Drains are constructed by excavating a trench and installing perforated pipe on aggregate base laid at the bottom of the trench. The portion of the trench in saturated soil is then backfilled with aggregate or other envelope material. The remainder of the trench is backfilled with soil. A geotextile may also be installed in the trench to prevent fine soil particulates from clogging the drain. If the saturated soil has a moderate or high hydraulic conductivity, then a low-permeability geomembrane may be placed on the down gradient side of the trench to prevent groundwater from passing through the drain. Gravity drains could discharge to a sanitary sewer manhole, storm drain manhole or catch basin, or directly to a free-flowing stream or creek, if there is enough slope to the terrain. If the drain terminates below the entry point to the sewer, storm drain, or water body, a pump would be necessary to lift the water to the discharge point.

Drains are not feasible at depths exceeding 40 feet bgs due to the difficulty of shoring during construction (U.S. EPA, 1991c). Construction costs may be prohibitive if the trench is completed in bedrock and substantial quantities of rock must be excavated. Trench excavation is also complicated by underground utilities, or in areas where buildings and roads exist. Despite these limitations, drains may be more cost effective in certain circumstances. Drains may be particularly well suited to sites with relatively low hydraulic conductivities, where the costs to install wells may be high because of the need to locate wells close together. Use of trenches or drains is **retained** for further consideration.

8.3.8 In-situ Groundwater Treatment

In-situ groundwater treatment consists of remedial technologies that destroy COCs or reduce their toxicity or mobility without having to extract groundwater.

8.3.8.1 <u>In-situ Groundwater Treatment Using Physical/Chemical Technology</u>

Air sparging, reactive walls, and oxidation/reduction are the process options considered in this Presidio Trust Revised FS Report that use physical/chemical technology for in-situ treatment of groundwater.

8.3.8.1.1 Air Sparging

Air sparging, recirculating wells, and other similar processes cause VOCs to partition from groundwater into an air stream. The air stream containing VOCs is collected through an SVE system for subsequent treatment in most applications. This process option is **not retained** for further consideration because COCs in groundwater are predominantly metals that are not volatile under ambient conditions.

8.3.8.1.2 Permeable Reactive Walls

Permeable reactive walls consist of a permeable and reactive medium installed in a trench constructed across the groundwater flow path. A permeable reactive wall allows passage of groundwater while transforming COCs to harmless byproducts. The Ground-Water Remediation Technologies Analysis Center ("GWRTAC")[27] indicates in its technology evaluation report, entitled *Treatment Walls,* dated October 1996, that zero-valent iron is the most common reactive medium used in permeable reactive walls.

A primary design concern of a permeable reactive wall is ensuring that COC-containing groundwater passes through the structure (U.S. EPA, 1998a). The medium in the permeable reactive wall should be at least as permeable as the soil in the saturated zone. In some cases, a subsurface barrier (e.g., interlocking sheet piling) is installed along the edges of the area containing groundwater with dissolved COCs. The barrier is installed in a configuration similar to a funnel, directing groundwater to flow through the permeable reactive wall, or "gate," at the down gradient end of the "funnel." This arrangement is called a "funnel and gate" design, and can be used to improve confidence in the capture of impacted groundwater.

A primary operational concern with permeable reactive walls is the longevity of the system (U.S. EPA, 1998a). Plugging or coating of the reactive medium can occur if minerals precipitate in or on the medium (e.g., calcium carbonate scale). The reductive dehalogenation process of chlorinated organic solvents tends to increase the pH of the groundwater, enhancing the tendency for scale formation. To mitigate this concern, designs have been developed that allow for periodic replacement or cleaning of the reactive medium.

Use of permeable reactive walls is an emerging physical/chemical process. Application of the process is limited. As of 1998, only thirteen full-scale permeable reactive walls had been installed throughout the United States. These walls were treating either chlorinated organic solvents or hexavalent chromium in groundwater using zero-valent iron as the reactive medium (U.S. EPA, 1998a, 1997h, 1995f).

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[27] GWRTAC is operated by Concurrent Technologies Corporation ("CTC"), in association with the University of Pittsburgh, through a cooperative agreement with U.S. EPA Technology Innovation office. According to CTC, GWRTAC reports are developed to provide a state-of-the-art review of a selected groundwater remediation technology or groundwater topic. GWRTAC reports contain information from peer-reviewed papers and publications, and in some instances, from personal communication with involved parties. GWRTAC reports are peer-reviewed before being released.

Low concentrations of hexavalent chromium have been detected in groundwater at several Main Installation sites, such as Building 215, Battery Howe/Wagner, Fill Site 1, and Landfill 2. Review of Montgomery Watson's study (1999c) of Presidio groundwater indicates that the hexavalent chromium detected is likely natural occurring, and caused by dissolution and oxidation of chromium minerals in serpentinite. Review of the Montgomery Watson study and associated supporting evidence that hexavalent chromium is natural occurring is presented in Sections 4.5.3 and 6.2.1.3.

Treatment of other metals (e.g., nickel, lead, zinc) detected in groundwater at Main Installation sites has not been demonstrated by full-scale applications of permeable reactive walls. Studies indicate that phosphates are a promising reactive medium for nickel, lead, and zinc. However, GWRTAC (1999) states that the results of these studies "may not directly apply to real soil or ground-water systems. Further studies need to be conducted using natural materials as matrices." Implementation of permeable reactive walls is **not retained** for further consideration.

8.3.8.1.3 Oxidation/Reduction

In-situ chemical oxidation or reduction processes involve injecting a chemical oxidant or reductant directly into saturated soil. Common oxidants include hydrogen peroxide and potassium permanganate. Reductants include sodium dithionite and hydrogen sulfide (GWRTAC, 1999; U.S. EPA, 1998b). The desired result of oxidation/reduction treatment is the complete transformation of COCs in groundwater to less toxic or non-toxic metal species, or water, carbon dioxide, and chloride ions.

The stratigraphy and geochemistry at a given site control the ability, amounts, and types of oxidants or reductants that must be delivered to the saturated zone. For example, if hydrogen peroxide is used to oxidize COCs in groundwater, the pH of saturated soil may have to be temporarily lowered and ferrous iron or other catalyst may have to be injected to facilitate the oxidation reaction. Groundwater may also have to be extracted to control undesired migration of the oxidants or reductants introduced into the subsurface.

In-situ chemical oxidation/reduction is an emerging physical/chemical process. Further, groundwater extraction may be required to control chemicals injected into the saturated zone. Oxidation/reduction is **not retained** for further consideration because other suitable and more reliable processes exist for removing or treating COCs detected in groundwater at Main Installation sites.

8.3.8.2 <u>In-situ Groundwater Treatment Using Biological Technology</u>

Bioremediation described in Section 8.3.4.3.2 can be performed by introducing oxygen and/or nutrients to groundwater. Bioremediation is **not retained** for further consideration because COCs at Main Installation sites are metals that are not readily removed by biological treatment.[28]

[28] This technology may be appropriate for sites with petroleum hydrocarbons in groundwater.

8.3.9 Ex-situ Groundwater Treatment

If groundwater is extracted at Main Installation sites, it is unlikely that ex-situ treatment of this water will be performed. Demonstrated ex-situ methods of treatment are not anticipated to remove COCs from extracted groundwater to concentrations that will allow the water to be discharged to Tennessee Hollow, Crissy Field wetlands, Lobos Creek, or other surface water bodies at the Presidio. Freshwater quality objectives listed in the *Water Quality Control Plan* (RWQCB, 1995) and under the California Toxics Rule (40 CFR §131.38) have been adopted as cleanup levels for surface water at the Presidio. As discussed in Sections 8.3.9.1.1 through 8.3.9.1.6, available treatment methods are incapable of removing COCs from extracted groundwater such that these cleanup levels can be reliably achieved.[29]

Although COCs in groundwater are greater than freshwater quality objectives, the maximum concentrations of these chemicals are generally less than the limitations on discharge to the sanitary sewer established by the City and County of San Francisco, Public Utilities Commission (1999). For example, the highest concentration of nickel in groundwater is 2,450 µg/L, or 2.45 mg/L, detected at Landfill E at only one location. The limitation for discharge of nickel to the sanitary sewer is 2 mg/L. Based upon comparison of maximum concentrations of COCs detected in groundwater with corresponding discharge limitations, it is possible that extracted groundwater could be disposed to the sanitary sewer without having to be treated.

8.3.9.1 Ex-situ Groundwater Treatment Using Physical/Chemical Technology

Air stripping, adsorption, membrane separation, precipitation/coagulation, ion exchange, and advanced oxidation are the process options considered in this Presidio Trust Revised FS Report that use physical/chemical technology for ex-situ treatment of groundwater.

8.3.9.1.1 Air Stripping

Air stripping is a physical process that transfers VOCs from water to air. VOC-containing groundwater is pumped to the top of a tower and distributed across trays or random packing. The water flows downward as a thin film across these surfaces. Air is blown into the base of the tower and travels upward. The trays or packing in the tower provide a large surface area and the flow of air creates a high level of turbulence. These two factors enhance mass transfer to the air. Subsequent treatment is often performed to recover or destroy VOCs in the air stream leaving the top of the tower.

Air stripping is a presumptive remedy for treatment of VOCs in groundwater (U.S. EPA, 1996c). However, air stripping is **not retained** for further consideration because VOCs are only infrequently detected and the predominant COCs at Main Installation sites are metals.

[29] For other waste streams, such as domestic wastewater, these technologies may be appropriate.

8.3.9.1.2 Adsorption

Adsorption of COCs onto GAC, activated alumina, or other media is commonly used for treatment of chemical-containing groundwater. The media is placed as columns or beds in cylindrical vessels. GAC adsorption is a presumptive remedy for treatment of organic compounds in groundwater (U.S. EPA, 1996c).

Physical adsorption of COCs onto GAC results from the action of van der Waals forces, which are relatively weak interactions produced by the motion of electrons in their orbitals. Physical adsorption is normally a reversible process and COCs that have accumulated on GAC can be released back into treated water. Short-circuiting through the GAC bed can also cause COCs to be detected in treated water exiting the vessel. These operational difficulties are especially of concern given that most of the surface water cleanup levels for organic compounds and metals found at Main Installation sites are near analytical method reporting limits. These low cleanup levels provide little tolerance for less than ideal performance of a GAC treatment system. For this reason, adsorption is **not retained** for further consideration.

8.3.9.1.3 Membrane Separation

Membrane separation includes reverse osmosis, ultrafiltration, and electrodialysis. These processes involve forcing chemical-containing groundwater through a semi-permeable membrane to separate the COCs in a concentrate stream and clean water in a permeate stream. Reverse osmosis is a presumptive remedy for treatment of metals in groundwater (U.S. EPA, 1996c). U.S. EPA also designated reverse osmosis as BAT in its establishment of the lead and copper rule for drinking water (40 CFR §141). Reverse osmosis was found to remove lead to concentrations of 5 µg/L (53 FR 31516-31578). Although this concentration is less than the action level of 15 µg/L at which drinking water must be treated for removal of lead, it is still greater than the freshwater quality objective of 3.2 µg/L adopted as a cleanup level for surface water at the Presidio. Membrane separation is **not retained** for further consideration.

8.3.9.1.4 Precipitation/Coagulation

Precipitation involves mixing chemical reagents in water to convert soluble COCs to insoluble forms. Coagulation involves mixing chemical reagents in water to cause soluble COCs to aggregate into flocs. Precipitates and flocs are subsequently removed from water by settling and/or filtration. Precipitation/coagulation is a presumptive remedy for treatment of metals in groundwater (U.S. EPA, 1996c) and is BAT for treatment of lead and copper in drinking water (40 CFR §141). Although precipitation/coagulation can reduce lead concentrations to approximately 5 µg/L, it is unlikely to achieve cleanup levels for lead and other metals in surface water at the Presidio. This process option is **not retained** for further consideration.

8.3.9.1.5 Ion Exchange

Ion exchange captures ionic COCs in groundwater on a resin. The resin is placed as columns or beds in cylindrical vessels. According to Freeman (1989), ion exchange resins can be described "simply as solid, insoluble acids or bases that are capable of entering into chemical reactions in the same way as their mineral or organic acid analogs."

Ion exchange is a presumptive remedy for treatment of metals in groundwater (U.S. EPA, 1996c) and is BAT for treatment of lead and copper in drinking water (40 CFR §141). Although ion exchange can reduce lead concentrations to approximately 5 µg/L, it is unlikely to achieve cleanup levels for lead and other metals in surface water at the Presidio. This process option is **not retained** for further consideration.

8.3.9.1.6 Advanced Oxidation

Advanced oxidation entails using strong oxidants to destroy COCs in groundwater. Common oxidants include hydrogen peroxide, ozone, and ultraviolet light. These oxidants can be used alone or in combination to destroy COCs. Although advanced oxidation is a presumptive remedy for treatment of organic compounds in groundwater (U.S. EPA, 1996c), it is not likely to reliably achieve cleanup levels for COCs in surface water at the Presidio. This process option is **not retained** for further consideration.

8.3.9.2 Ex-situ Groundwater Treatment Using Biological Technology

Bioremediation described in Section 8.3.4.3.2 can be performed ex-situ as well as in-situ. Bioremediation is **not retained** for further consideration because COCs at Main Installation sites are predominantly metals that are not readily removed by biological treatment.

8.3.10 Extracted Water Discharge

Groundwater and surface water extracted or collected from Main Installation sites must be managed. Potential means of management evaluated in this Presidio Trust Revised FS Report consist of discharge to surface water, discharge to the sanitary sewer, and reinjection into the subsurface.

8.3.10.1 Discharge to Surface Water

Discharge of extracted or collected water to Tennessee Hollow, Crissy Field wetlands, Lobos Creek, or other surface water bodies at the Presidio may require that the RWQCB issue a NPDES permit depending upon whether the discharge to the receiving water is determined to occur on-site or off-site. Freshwater quality objectives listed in the *Water Quality Control Plan* (RWQCB, 1995) and under the California Toxics Rule (40 CFR §131.38) have been adopted as cleanup levels for surface water at the Presidio.

It is unlikely that COCs in groundwater or surface water can be removed to low concentrations that achieve these cleanup levels. Because of the difficulty in adequately removing COCs, discharge of extracted and treated water to surface water is not anticipated to be feasible.

However, extracted or collected groundwater that does not contain COCs from Main Installation sites may be discharged to surface water under a NPDES permit. Clean water may have to be managed if subsurface barriers or extraction are used to divert such groundwater around a landfill or impacted soil. Discharge to surface water is **retained** for further consideration.

8.3.10.2 Discharge to Sanitary Sewer

The City SFDPW operates the sanitary sewers and POTW in San Francisco. Municipal wastewater generated at the Presidio is discharged to the San Francisco sewer system for treatment. It may also be possible to discharge extracted chemical-containing groundwater from Main Installation sites to the sanitary sewer if sufficient capacity in the system exists. Concentrations of COCs in groundwater are below limitations on discharge to the sanitary sewer established by the City and County of San Francisco, Public Utilities Commission (1999). Therefore, extracted groundwater could be disposed to the sanitary sewer without having to be treated. This potential means of managing water is **retained** for further consideration.

8.3.10.3 Reinjection

Reinjection involves pumping extracted and treated water into the subsurface through use of vertical wells. The formation of bubbles or microbial growth on well screens can complicate reinjection of groundwater. The effects of reinjection on groundwater flow patterns and the watershed at the Presidio must also be examined. Studies would be necessary to evaluate the potential effects on enhancement projects, such as the planned restoration of Tennessee Hollow, the rehabilitation of Mountain Lake, and increased surface water flow to Lobos Creek. The time to complete these studies might result in delays of the enhancement projects or implementation of remedial actions at Main Installation sites. For this reason, reinjection is **not retained** for further consideration.

8.4 SUMMARY OF TECHNOLOGIES RETAINED FOR FURTHER CONSIDERATION

Based upon the results of screening performed in Section 8, the general response actions, remedial technologies, and process options retained for further consideration are summarized in the below table. Check marks in the table indicate if the general response actions, remedial technologies, and process options apply to soil and sediment, or surface water and groundwater.

SUMMARY OF RETAINED TECHNOLOGIES				
General Response Action	Remedial Technology	Process Option	Media for Which Retained Technology is Applicable	
			Soil and Sediment	Surface Water and Groundwater
• No Action			✓	✓
• Institutional Controls	Land Use Controls		✓	✓
	Monitoring		✓	✓
• Containment	Permeable Cover Systems		✓	
	Low Permeability Cover Systems	Geosynthetic Cover	✓	
• Ex-situ Soil Treatment	Physical/Chemical Technology	Immobilization	✓	
• Excavation	Disposal of Wastes and Soil Off-site		✓	
	Segregation of Wastes and Soil	Reuse of Soil at Presidio	✓	
		Disposal of Soil as Daily Cover	✓	
		Segregation and Recycling of Wastes	✓	
		Disposal of Wastes Off-site	✓	
• Collection/ Diversion	Subsurface Barriers	Slurry Wall		✓
		Sheet Piling		✓
	Extraction	Wells		✓
		Trenches		✓
• Extracted Water Discharge	Discharge to Surface Water			✓
	Discharge to Sanitary Sewer			✓

Section 9 summarizes the development and screening of remedial alternatives using the technologies retained from this section. Section 10 presents the detailed analysis of alternatives.

9. DEVELOPMENT AND SCREENING OF ALTERNATIVES

General response actions, remedial technologies, and process options passing the screening performed in Section 8 have been developed into remedial alternatives for Main Installation landfills and miscellaneous sites.

9.1 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Following the methodology in U.S. EPA (1988a) *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, general response actions, remedial technologies, and process options for soil and sediment, and surface water, seeps, and groundwater (collectively "soil and water") have been combined to create potential alternatives that address COCs at landfills and miscellaneous sites as a whole. A range of options has been developed that include the no action alternative; a limited action alternative consisting of monitoring water only; source containment alternatives with and without water response actions; and source treatment or removal alternatives with and without water response actions. Potential remedial alternatives for landfills and miscellaneous sites include the following:

Potential Landfill Remedial Alternatives

- No action for soil and water.
- Maintain existing cover over soil and waste, and no action for water.
- Maintain existing cover over soil and waste, and monitor water.
- Construct low-permeability geosynthetic cover over soil and waste, and monitor water.
- Construct low-permeability geosynthetic cover over soil and waste, and divert water around landfill through a combination of subsurface barriers, and discharge of groundwater to surface water.
- Construct low-permeability geosynthetic cover over soil and waste, and extract and discharge groundwater to sanitary sewer.
- Immobilize soil contaminants in place and monitor water.
- Excavate and dispose of soil and waste off-site, and monitor water.

- Excavate, segregate, and recycle soil and waste, and monitor water.[30]

Potential Miscellaneous Site Remedial Alternatives

- No action for soil and water.
- No action for soil and monitor water.
- Construct permeable cover over soil and no action for water.
- Construct low-permeability cover over soil and monitor water.
- Immobilize soil contaminants in place and monitor water.
- Excavate and dispose of soil and waste off-site, and no action for water.
- Excavate and dispose of soil and waste off-site, and monitor water.
- Excavate and dispose of soil and waste off-site, and extract and discharge groundwater to sanitary sewer.

Given the varied environmental conditions at Main Installation sites, not all potential remedial alternatives developed for landfills and miscellaneous sites will pertain to each site. For example, available analytical results indicate that soil and building debris in Fill Site 6 outside the east of Halleck and west of Girard Road area and the Building 1065 Area do not contain soluble COCs and groundwater at this site has not been adversely impacted. As a consequence, remedial alternatives involving the use of a low-permeability cover, or groundwater diversion or extraction options need not be considered for Fill Site 6.

9.2 SCREENING OF REMEDIAL ALTERNATIVES

To potentially reduce the remedial alternatives that must undergo detailed analysis, the NCP at 40 CFR §300.430(e)(7) provides the opportunity to screen alternatives against the short- and long-term aspects of the following three criteria:

- **Effectiveness:** Alternatives are judged on the degree to which an alternative reduces toxicity, mobility, or volume through treatment, minimizes residual risks and affords long-term protection, complies with ARARs, minimizes short-term impacts, and how quickly it achieves protection. Alternatives providing significantly less effectiveness than other, more promising alternatives may be

[30] As discussed in Section 8.3.6.2, segregation of wastes and soil can include all the process options of reuse of soil at the Presidio, disposal of soil as daily cover, recycling, and off-site disposal.

eliminated. Alternatives that do not provide adequate protection of human health and the environment shall be eliminated from further consideration.

- **Implementability:** This criterion focuses on the technical feasibility and availability of the technologies each alternative would employ and the administrative feasibility of implementing the alternative. Alternatives that are technically or administratively infeasible, or require equipment, specialists, or facilities that are not available within a reasonable period of time may be eliminated from further consideration.

- **Cost:** Costs of construction and any long-term costs to operate and maintain the alternatives shall be considered. Costs that are grossly excessive compared to the overall effectiveness of alternatives may be used as a factor to exclude alternatives from further consideration. Alternatives providing effectiveness and implementability comparable to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may also be eliminated.

Tables 9-1 and 9-2 summarize the screening of landfill and miscellaneous site remedial alternatives against these three criteria. Screening of alternatives was conducted to eliminate those remedial alternatives that cannot be applied to any of the Main Installation landfills or miscellaneous sites based upon the criteria of effectiveness, implementability, and cost. The nature and extent of chemicals at landfills and miscellaneous sites described in Section 6 are used to determine which of the retained alternatives apply to individual sites and undergo detailed analysis in Section 10.

9.2.1 Results of Landfill Remedial Alternative Screening

Results of screening of landfill remedial alternatives are discussed in Sections 9.2.1.1 through 9.2.2.8.

9.2.1.1 No Action

The no action alternative for soil and water will not achieve RAOs at landfills with COCs in soil or sediment, and groundwater or surface water above applicable cleanup levels. This alternative can be easily implemented and costs are negligible because no further activities need to be performed. A landfill where this alternative may be applicable is Graded Area 9. In addition, the NCP at 40 CFR §300.430(e)(6) requires that the no action alternative be evaluated as a baseline for comparison of other alternatives developed. This alternative is **retained** for detailed analysis.

9.2.1.2 Permeable Cover/No Action for Water

This alternative would involve a permeable cover system to prevent contact with chemical-containing soil and waste in Main Installation landfills. Cover materials would possibly consist of clean soil, or asphalt, concrete walk-ways, and building slabs if the

GMPA or PTMP allows for construction of improvements at areas where Main Installation landfills are located. The remedy would include a conceptual monitoring plan including routine inspections of the cover system; land use controls including the Trust and NPS' land use compliance processes, a site-specific addendum to the LUCMRR, and the Presidio-wide LUCMRR (Section 8.3.2.1); and an operations and maintenance plan for ongoing maintenance. Land use controls are intended to ensure that the integrity of the cover remains intact and any digging beneath the cover that may take place is being conducted in a manner that does not cause potential risk to human health and the environment.

Since a permeable cover is not designed to restrict infiltration of surface water, use of a permeable cover without water response actions is appropriate for a landfill where no impacts to groundwater have been observed or are anticipated. Implementability of this alternative depends upon the characteristics of the individual landfill, such as local topography, geophysical conditions, and surface area of the soil and waste to be contained. Construction or maintenance of existing permeable cover systems typically have low to moderate capital cost, and low annual cost. Potential landfills where this alternative may be applicable are Battery Howe/Wagner and Fill Site 6. This alternative is **retained** for detailed analysis.

9.2.1.3 Permeable Cover/Water Monitoring

This alternative also employs a permeable cover system and land use controls to prevent humans and ecological receptors from contacting soil and waste with COCs. The remedy would include a conceptual monitoring plan including routine inspections of the cover system; land use controls including the Trust and NPS' land use compliance processes, a site-specific addendum to the LUCMRR, and the Presidio-wide LUCMRR; and an operations and maintenance plan for ongoing maintenance. Surface water, seep, and groundwater monitoring would be performed at those sites where it is suspected that the landfill contents do not contain soluble COCs but available analytical data are ambiguous as to the effects of the landfill on local surface water, seep, and groundwater conditions. The site-specific addendum to the LUCMRR would be employed to prevent the use of surface water or groundwater that has been impacted. Surface water, seep, and groundwater monitoring would be conducted to verify attenuation of dissolved COCs in water or would otherwise be performed until such time that the source of COCs detected in groundwater or surface water is identified. Construction or maintenance of an existing permeable cover with groundwater or surface water monitoring is expected to have low to moderate capital cost, and low to moderate annual cost. Battery Howe/Wagner and Fill Site 6 are potential landfills where this alternative may be applicable. This alternative is **retained** for detailed analysis.

9.2.1.4 Low-Permeability Cover/Water Monitoring

Low-permeability geosynthetic cover systems are designed to promote surface water drainage away from the cap and to minimize infiltration of water into the soil and waste containing COCs. A low-permeability cover would be used at sites where the landfill

contents may leach COCs to groundwater. The remedy would include a conceptual monitoring plan including routine inspections of the cover system; land use controls including the Trust and NPS' land use compliance processes, a site-specific addendum to the LUCMRR, and the Presidio-wide LUCMRR; and an operations and maintenance plan for ongoing maintenance. The site-specific addenda to the LUCMRR for groundwater would entail monitoring and restrictions that prevent use of groundwater.

Implementability of this alternative depends upon the characteristics of the individual landfill, including the local topography, geophysical conditions, and surface area of soil and waste to be contained. Construction of a low-permeability geosynthetic cover with groundwater monitoring is expected to have moderate capital cost, and low to moderate annual cost. Landfill E, Fill Site 1, Landfill 2, Landfill 4, Fill Site 5,[31] and Baker Beach Disturbed Area 3 are potential landfills where this alternative may be applicable. This alternative is **retained** for detailed analysis.

9.2.1.5 Low-Permeability Cover/Surface Water Discharge of Groundwater

Similar to other containment options, this alternative employs the use of a low-permeability geosynthetic cover with land use controls to prevent humans and ecological receptors from contacting landfill contents. The remedy would include a conceptual monitoring plan including routine inspections of the cover system; land use controls including the Trust and NPS' land use compliance processes, a site-specific addendum to the LUCMRR, and the Presidio-wide LUCMRR, and an operations and maintenance plan for ongoing maintenance. For Main Installation landfills where impacted soil and waste extend into the saturated zone, subsurface barriers, such as slurry walls or sheet piling, would be employed to prevent groundwater from becoming contaminated by contact with these materials by diverting clean groundwater around the landfill. Alternatively, wells or trenches may be used in conjunction with subsurface barriers (e.g., slurry walls, sheet piling, trench with a low-permeability geomembrane placed on the down gradient side of trench) to divert and protect groundwater. Collected clean groundwater would be discharged to surface water. Monitoring of both surface water and groundwater would be performed to evaluate the performance of remedial actions and to verify that discharge requirements are achieved.

Implementability of this alternative depends upon the characteristics of the individual landfill, such as local topography, geophysical conditions, hydrogeology, surface area of waste to be contained, and distance to the location where extracted groundwater is to be discharged. Construction of a low-permeability geosynthetic cover combined with extraction and discharge of groundwater to surface water is expected to have high capital cost, and moderate annual cost. The potential landfill location where this alternative may be applicable is Landfill E. This alternative is **retained** for detailed analysis.

[31] Remedial alternatives for Landfill 4 and Fill Site 5 have been determined in a separate RAP (Treadwell & Rollo, 2002c). However, these sites are discussed in this Section 9 for completeness.

9.2.1.6 Low-Permeability Cover/Sanitary Sewer Discharge of Groundwater

Under this alternative, a low-permeability geosynthetic cover would be placed over the landfill and groundwater in the vicinity of the landfill that contains COCs would be extracted from wells or trenches and discharged directly to the sanitary sewer. Although COCs in groundwater are greater than freshwater quality objectives, the maximum concentrations of these chemicals are generally less than the limitations on discharge to the sanitary sewer. The other components of low-permeability geosynthetic covers discussed above would also apply.

Implementability of this alternative depends upon the characteristics of the individual landfill, such as local topography, geophysical conditions, hydrogeology, surface area of waste to be contained, concentrations of COCs in extracted groundwater, and distance to the sanitary sewer. Construction of a low-permeability geosynthetic cover combined with extraction and discharge of groundwater to the sanitary sewer is expected to have high capital cost, and moderate to high annual cost. The potential landfill location where this alternative may be applicable is Landfill E. This alternative is **retained** for detailed analysis.

9.2.1.7 Immobilization/Water Monitoring

Ex-situ immobilization refers to processes that change the toxicity, or physical or leaching characteristics of COCs in soil by mixing chemical reagents with impacted soil. While the effectiveness of immobilization to reduce the toxicity of metals is well demonstrated, the process is often difficult to perform on the contents of landfills because extensive pretreatment is required to separate and crush oversize materials that can interfere with mixing of reagents with soil. Given the expense of pretreatment and addition of chemical reagents, immobilization is generally cost-effective under select circumstances, such as when soil, that exhibits characteristics of a RCRA-hazardous waste, can be changed by immobilization to allow the soil to be managed on-site, or disposed off-site as non-RCRA hazardous or non-hazardous solid waste. Under these circumstances, the high capital cost of immobilization are off-set by the taxes and expenses that would have been associated with transporting, treating, and disposing of soil as RCRA-hazardous waste at an off-site permitted facility.

However, review of available analytical data suggests that most soil in Main Installation landfills contains metals at concentrations that are only slightly greater than applicable cleanup levels. The concentrations of metals would not generally require soil excavated from Main Installation landfills to be managed as RCRA-hazardous waste if this soil is disposed off-site. Immobilization is not expected to be more effective or easier to implement than containment, or excavation and off-site disposal. Costs of these remedial alternatives are anticipated to be significantly less than that for immobilizing soil removed from Main Installation landfills. Immobilization is **not retained** for detailed analysis.

9.2.1.8 Excavate and Dispose of Soil and Waste Off-site/Water Monitoring

This alternative would entail excavating the contents of Main Installation landfills and disposing of the material in a waste management unit at an off-site, permitted facility. Excavation of landfills is also referred to as clean closure and is anticipated to be effective in eliminating risks to human health and the environment. The effectiveness of clean closing Main Installation landfills is based upon available information that does not suggest that significant quantities of chemicals have leached into soil beneath the landfills or created NAPLs in the saturated zone that could act as ongoing sources of contamination after the landfill contents have been removed. Confirmation soil sampling would be conducted to verify the extent of excavation.

Restrictions on land use are not anticipated to be required because clean closure is likely to remove COCs in native soil to concentrations that present negligible risk. However, if the remedial action does not achieve residential cleanup levels, land use controls, including a site-specific addendum to the LUCMRR restricting residential reuse, may be required for the site.

Surface water, seep, and groundwater monitoring for a minimum period of three years would be performed to comply with substantive requirements of Title 27 of the CCR for landfill closure, and to confirm attenuation of the concentrations of COCs, if any, detected in surface water, seeps, or groundwater that may have been associated with the presence of the landfill.

Implementability of this alternative depends upon the volume and types of soil and waste in the landfill, and where the landfill is located within the Presidio. Trenching conducted by the Trust at Fill Site 1 and Landfill 4 in July 2000 did not result in liberation of significant odors, methane, noxious gases (e.g., hydrogen sulfide or VOCs), or airborne particulates (e.g., dust or ACM). These findings suggest that odor, gas, and dust control may not materially hamper landfill excavation. Excavation and disposal of soil and waste off-site with groundwater and surface water monitoring is expected to have moderate to high capital cost, and low annual cost. Potential landfill locations where this alternative may be applicable include Battery Howe/Wagner, Fill Site 6, Landfill E, Fill Site 1, Landfill 2, Landfill 4, Fill Site 5, and Baker Beach Disturbed Areas 1, 2, and 3. This alternative is **retained** for detailed analysis.

9.2.1.9 Excavate, Segregate, and Recycle Soil and Waste/Water Monitoring

Under this alternative, a variation of excavation and direct disposal described above, landfill contents would be segregated and recycled to lessen the volume of excavated material that must be disposed in a waste management unit at an off-site, permitted facility. As described in Section 8.3.6.2, segregation of wastes and soil could include reuse of soil at other locations on the Presidio; disposal of soil as daily cover; recycling of wood and green wastes, metal, and concrete; and off-site disposal of material that cannot be segregated or recycled. The economic impact and feasibility of segregation and recycling versus direct disposal will also influence the volumes of materials that enter the

various recycling or disposal waste streams. Confirmation soil sampling would be conducted to verify the extent of excavation.

Restrictions on land use are not anticipated to be required because clean closure is likely to remove COCs in native soil to concentrations that present negligible risk. However, if the remedial action does not achieve residential cleanup levels, land use controls, including a site-specific addendum to the LUCMRR restricting residential reuse, may be required for the site.

Surface water, seep, and groundwater monitoring would be performed to comply with substantive requirements of Title 27 of the CCR for landfill closure, and to confirm attenuation of the concentrations of COCs, if any, detected in surface water, seeps, or groundwater that may have been associated with the presence of the landfill.

Implementability of this alternative depends upon the volume and types of soil and waste in the landfill, percentage of recyclable materials, and where the landfill is located within the Presidio. If the landfill does not have sufficient space to accommodate temporary staging of fill then another location at the Presidio (e.g., Fill Site 1 for excavation at Landfill 2, areas at Fort Scott) may be identified so segregation of soil from debris and further screening of debris can be accomplished. Alternatively, segregation and recycling may be conducted at an off-site location or facility. If excavation, segregation, and recycling of soil and waste is selected as a component of the remedial alternative, but the field application is not practicable, off-site waste disposal may be implemented. Such a change will not be considered a change or revision of the selected remedy. Excavation, segregation, and recycling of soil and waste with groundwater monitoring is expected to have moderate to high capital cost, and low annual cost. Potential landfill locations where this alternative may be applicable include Battery Howe/Wagner, Fill Site 6, Fill Site 1, Landfill E, Landfill 2, Landfill 4, Fill Site 5, and Baker Beach Disturbed Areas 1, 2, and 3. This alternative is **retained** for detailed analysis.

9.2.2 Results of Miscellaneous Site Remedial Alternative Screening

Results of screening of miscellaneous sites remedial alternatives are discussed in Sections 9.2.2.1 through 9.2.2.8.

9.2.2.1 No Action

The NCP requires that the no action alternative be evaluated as a baseline for comparison of other alternatives developed. Although this alternative will not achieve RAOs where concentrations of COCs in soil and groundwater are above applicable cleanup levels, there are miscellaneous sites where no COCs are found above cleanup levels. As discussed in Section 6, these sites include Sewer Lift Station No. 2, Former Building 609 Area, Building 1245 Area, Building 1369 Area, Building 1388 Area, Building 1057, Building 1151/1153 Area, Building 680 Area, El Polin Spring, Former Building 611 Area, Former Building 302 Area, Building 1450/1451 Area, Building 1750 Area, and Lobos Creek. No action may be an appropriate remedial alternative for these sites. This

alternative can be easily implemented and costs are negligible because no further activities need to be performed. In addition, as summarized in Table 6-4, all of these sites, except Building 1151/1153 Area and Building 680 Area, also meet residential cleanup levels, which means that land use controls are not required to restrict residential use of such sites. This alternative is **retained** for detailed analysis.

9.2.2.2 No Action/Water Monitoring

No action would be performed at miscellaneous sites where there is sufficient information to conclude that a chemical release has not occurred. However, surface water, seep, and/or groundwater monitoring would be conducted at those sites where available information is ambiguous as to the effects of the miscellaneous sites on local groundwater conditions. Land use controls, involving excavation permit programs, project review, or easements, would be employed to prevent the use of surface water or groundwater that has been impacted. Surface water, seep, and/or groundwater monitoring would be conducted in accordance with a monitoring plan to verify attenuation of dissolved COCs in water or otherwise would be performed until such time that the source of COCs detected in surface water, seeps, or groundwater is identified.

This alternative can be easily implemented, and is expected to have low capital cost, and low to moderate annual cost. For example, El Polin Spring is considered No Further Action, but seeps at El Polin Spring would be monitored as part of the remedies for Fill Site 1 and Landfill 2. Building 215 and Nike Swale are potential miscellaneous sites where this alternative may be applicable. This alternative is **retained** for detailed analysis.

9.2.2.3 Permeable Cover/No Action for Water

As discussed in Section 6, the predominant COCs in soil and sediment at miscellaneous sites are metals or other insoluble compounds, such as PAHs. Since metals and PAHs do not pose a leaching threat to groundwater, use of a permeable cover is likely to be effective in protecting human health and the environment from these COCs. However, there are as many as thirteen miscellaneous sites have soil with metals or PAHs that may require remedial actions. Inspecting and maintaining caps at all these relatively small sites is likely to prove to be administratively infeasible and may interfere with reuse as contemplated under the GMPA or PTMP. Use of permeable covers at miscellaneous sites is **not retained** for detailed analysis.

9.2.2.4 Low-Permeability Cover/Water Monitoring

Use of a low-permeability geosynthetic cover is not indicated because COCs at miscellaneous sites are insoluble and infiltration of surface water through soil containing COCs at these sites is not a primary concern. Further, construction of low-permeability geosynthetic cover systems at the many miscellaneous sites that have metals or PAHs in soil would not alleviate the administrative burden of inspecting and maintaining the caps,

and may interfere with reuse under the GMPA or PTMP. This alternative is **not retained** for detailed analysis.

9.2.2.5 Immobilization/Water Monitoring

The effectiveness of immobilization to reduce the toxicity of metals in soil is well demonstrated. However, as discussed in Section 9.2.1.7, soil at miscellaneous sites contains metals at concentrations that are only slightly greater than applicable cleanup levels. Metal-containing soil can be excavated and disposed at an off-site permitted waste management facility at considerably less cost than immobilizing metals in soil and attempting to reuse the immobilized soil at the Presidio. Immobilization is **not retained** for detailed analysis.

9.2.2.6 Excavate and Dispose of Soil and Waste Off-site/No Action for Water

The low concentrations of COCs and relatively small volumes of impacted soil or sediment at most miscellaneous sites suggest that excavation and off-site disposal of chemical-containing soil and sediment would likely be effective and easy to implement at these sites. Confirmation soil sampling would be conducted to verify the extent of excavation.

Restrictions on land use are not anticipated to be required because excavation is likely to remove COCs in native soil to concentrations that present negligible risk. However, if the remedial action does not achieve residential cleanup levels, land use controls, including a site-specific addendum to the LUCMRR restricting reuse, may be required for the site.

No action for water would be required for miscellaneous sites where analytical data are sufficient to determine that no releases of COCs to surface water, seeps, or groundwater have occurred. Excavation and disposal of soil and waste off-site is expected to have low to high capital cost, and low annual cost. Potential miscellaneous site locations where this alternative may be applicable include Building 1244 Area, Building 1351 Area, Building 1167 Area, Building 662 Area, Building 669 Area, Sewer Lift Station No. 1, Building 633 Firing Range, Mountain Lake, Nike Swale, Transfer Station Area, and Baker Beach Disturbed Areas 1A and 4. Excavation and disposal of soil and waste off-site with no action for water is **retained** for detailed analysis.

9.2.2.7 Excavate and Dispose of Soil and Waste Off-site/Water Monitoring

Excavation and disposal of soil and waste off-site would be combined with groundwater monitoring for miscellaneous sites where available analytical data are ambiguous as to the effects of the site on local groundwater conditions. Confirmation soil sampling would be conducted to verify the extent of excavation.

Restrictions on land use are not anticipated to be required because excavation is likely to remove COCs in native soil to concentrations that present negligible risk. However, if

the remedial action does not achieve residential cleanup levels, land use controls, including a site-specific addendum to LUCMRR restricting reuse, may be required for the site.

The remedy would include a groundwater monitoring plan. Surface water, seep, and/or groundwater monitoring would be conducted to verify attenuation of dissolved COCs in water or would otherwise be performed until such time that the source of COCs detected in surface water, seeps, or groundwater is identified.

Excavation and disposal of soil and waste off-site with water monitoring is expected to have low to high capital cost, and low to moderate annual cost. Potential miscellaneous sites where this alternative may be applicable include Sewer Lift Station No. 1 and Nike Facility. This alternative is **retained** for detailed analysis.

9.2.2.8 Excavate and Dispose of Soil and Waste Off-site/Sanitary Sewer Discharge

Under this alternative, soil and waste containing COCs at miscellaneous sites would be excavated and disposed off-site. Confirmation soil sampling would be conducted to verify the extent of excavation. If more than three or four metals are present as site COCs, DTSC has requested that samples be analyzed for the entire Title 22 metals suite during confirmation sampling.

Restrictions on land use are not anticipated to be required because excavation is likely to remove COCs in native soil to concentrations that present negligible risk. However, if the remedial action does not achieve residential cleanup levels, land use controls, including a site-specific addendum to the LUCMRR restricting reuse, may be required for the site.

The remedy would consist of a groundwater monitoring plan including routine inspections of the groundwater discharge system; possible easements to prevent the use of groundwater or surface water that has been impacted; and an operations and maintenance plan for ongoing maintenance. Groundwater in the vicinity of the site that contains COCs would be extracted from wells or trenches and discharged directly to the sanitary sewer. Although COCs in groundwater are greater than freshwater quality objectives, the maximum concentrations of these chemicals are generally less than the limitations on discharge to the sanitary sewer.

Implementability of this alternative depends upon the characteristics of the individual site, such as the hydrogeology, concentrations of COCs in extracted groundwater, and distance to the sanitary sewer. Excavation and disposal of soil and waste off-site combined with extraction and discharge of groundwater to the sanitary sewer is expected to have moderate to high capital cost, and moderate to high annual cost. Sewer Lift Station No. 1 and Nike Facility are the potential miscellaneous sites where this alternative may be applicable. This alternative is **retained** for detailed analysis.

9.3 SUMMARY OF RETAINED REMEDIAL ALTERNATIVES

Remedial alternatives retained for Main Installation landfills and miscellaneous sites include the following:

Retained Landfill Remedial Alternatives

- No action for soil and water.
- Maintain existing cover over soil and waste, and no action for water.
- Maintain existing cover over soil and waste, and monitor water.
- Construct low-permeability geosynthetic cover over soil and waste, and monitor water.
- Construct low-permeability geosynthetic cover over soil and waste, and divert groundwater around landfill through a combination of subsurface barriers, and extraction and discharge of groundwater to surface water.
- Construct low-permeability geosynthetic cover over soil and waste, and extract and discharge groundwater to sanitary sewer.
- Excavate and dispose of soil and waste off-site, and monitor water.
- Excavate, segregate, and recycle soil and waste, and monitor water.

Retained Miscellaneous Site Remedial Alternatives

- No action for soil and water.
- No action for soil and monitor water.
- Excavate and dispose of soil and waste off-site, and no action for water.
- Excavate and dispose of soil and waste off-site, and monitor water.
- Excavate and dispose of soil and waste off-site, and extract and discharge groundwater to sanitary sewer.

The applicability of retained remedial alternatives to individual landfills and miscellaneous sites was evaluated by taking into account the nature and extent of COCs at the Main Installation sites. Based upon this evaluation, ranges of remedial alternatives that pertain to conditions found at the sites have been assembled. Table 9-3 summarizes the remedial alternatives for each of the Main Installation landfills and miscellaneous sites that undergo detailed analysis in Section 10.

10. DETAILED ANALYSIS OF ALTERNATIVES

Section 9 described the remedial alternatives under consideration for Main Installation landfills and miscellaneous sites. Consistent with the NCP at 40 CFR §300.430(e)(9), a detailed analysis of these alternatives has been conducted in Section 10 to identify the preferred remedial alternative for each Main Installation site. The detailed analysis consists of an assessment of individual alternatives against each of nine evaluation criteria and a comparative analysis that focuses upon the relative performance of each alternative against those criteria. All alternatives selected for implementation at the Main Installation sites must meet the following two "Threshold Criteria":

Threshold Criteria:

- Provide short- and long-term protection of human health and the environment from unacceptable risks posed by the hazardous substances released into the environment.

- Comply with ARARs, unless the circumstances for a waiver apply. Site-specific ARARs are identified in Table 7-1.

Besides Threshold Criteria, five "Balancing Criteria" and two "Modifying Criteria" must be considered when selecting remedial alternatives to be implemented. Balancing and Modifying Criteria include the following:

Balancing Criteria:

- Long-term effectiveness and permanence

- Reduction of toxicity, mobility, or volume through treatment

- Short-term effectiveness

- Implementability

- Cost

Modifying Criteria:

- State acceptance

- Community acceptance

Balancing Criteria are used to identify the preferred alternatives from those that meet the Threshold Criteria. Modifying Criteria further shape the preferred alternatives by taking into account the concerns of state agencies and the public. After receiving input from the

state agencies and public, the alternatives selected for implementation are described in the ROD or, alternatively, the RAP. The RAP describes the ways in which releases of hazardous substances will actually be cleaned up and the RAP is used to subsequently control this remediation. The following six factors must be taken into account when preparing a RAP under Section 25356.1 of the California Health and Safety Code:

- Overall protection of human health and the environment
- Compliance with federal and state requirements
- Reduction of toxicity, mobility, and volume through treatment
- Long-term effectiveness and permanence
- Cost effectiveness
- Short-term effectiveness

Remedial alternatives for Main Installation sites have also been evaluated against these six factors in the Presidio Trust Revised FS Report. Tables 10-1 through 10-13 summarize the assessment of individual alternatives against each of the nine evaluation criteria specified in the NCP and the six factors specified under Section 25356.1 of the California Health and Safety Code. The results of the comparative analysis of remedial alternatives for Main Installation sites are summarized in Tables 10-14 through 10-37. Discussion of the preferred alternatives for Main Installation sites is organized by the GMPA planning areas where the sites are found, and is presented in Sections 10.1 through 10.10. Table 10-38 provides the total preliminary estimated costs of the preferred remedial alternatives. Preliminary estimated costs of each alternative considered for a site are included in the table summarizing the comparative analysis of alternatives for that site. Appendix E provides a breakdown of these costs. Preliminary estimated costs have been developed based upon site visits performed with representatives of the Trust, NPS, EKI, Golder, DeSilva Gates, and Jonas & Associates, and subsequent consultation with these representatives. In addition to capital costs for remedial activities, the cost estimates include additional items as may be applicable to each site. These may include:

- Investigation to define extent of area of impact;
- Number and analyses for soil confirmation samples for excavation alternatives (if more than three or four metals are present as site COCs, DTSC has requested that samples be analyzed for the entire Title 22 metals suite during confirmation sampling);
- Capital and annual costs for groundwater monitoring, including the proposed number of new and existing wells, sampling frequency, and analyses, and the

destruction of groundwater monitoring wells at the completion of remedial actions;

- Capital costs for restoration of sites on a per acre basis, which includes Trust-specific costs at the completion of remedial actions;

- Annual costs for monitoring engineered covers, including inspections, topographical surveys, and five-year review;

- Operation and maintenance costs for maintenance and repairs of remedial action components (e.g., low-permeability covers, groundwater extraction systems) that may degrade, fail, or otherwise require maintenance over time.

- Costs for land use controls that will be implemented as part of a remedial action (e.g., preparation of a site-specific addendum to the LUCMRR and long-term costs to implement, monitor, and enforce the land use controls).

The following conditions also apply to excavation alternatives, although not directly related to the cost estimates:

- In some cases, cleanup levels for metals were established as the background threshold concentration by lithology. During site remediation, it may be difficult to distinguish between background metals concentrations and residual chemical impacts. In these situations, it may be appropriate to use bivariate scatter plots and other statistical methods to determine if the excavation has achieved background levels since it is not practical to remediate below background.

- Similarly, in many cases, cleanup levels for special status species have been established at concentrations that are at or near the laboratory method reporting limit or other low concentrations. As a practical matter, it may be difficult to achieve these low cleanup levels during site remediation. In such cases, alternate ecological cleanup levels or risk management measures may need to be assessed in consultation with the regulatory agencies.

Unit costs and preliminary capital, annual, and total costs were initially prepared after site visits in August 2000 with representatives of the Trust, NPS, EKI, Golder, DeSilva Gates, and Jonas & Associates parties. To account for economic changes since August 2000, capital and annual costs have been updated with construction cost index factors from Engineering News Record.[32,33] Additional detail is provided in Appendix E for each site for which remedial actions are proposed.

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[32] The ratio of Engineering News Record's construction cost indices of October 2002 to July 2000 results in an escalation factor of approximately 6% in the two plus year time period. To update costs in the tables, the total estimated cost in 2000 dollars was multiplied by the escalation factor to calculate the estimated cost in 2002 dollars. The unit costs developed in 2000 were not adjusted. See Table E–3 of Appendix E for unit costs.

[33] Unit cost rates were developed to be applicable to a wide range of Presidio sites (See Table E-3 in Appendix E). In general, an assumed average-sized site was used to prepare unit rates. However, for very small sites, the unit rates may

10.1 MAIN POST

The preferred remedial alternatives for the Building 215 Area, Sewer Lift Station No. 2, and Former Building 609 Area are discussed in Sections 10.1.1 through 10.1.3.

10.1.1 Building 215 Area

Table 10-14 summarizes the detailed comparative analysis of potential remedial alternatives for the Building 215 Area. Based on the information currently available, Alternative 2, No Action for Soil and Monitor Water, is the preferred remedial alternative for the Building 215 Area. The impacted soil with fuel oil greater than applicable cleanup levels was recently removed by the Trust under its Petroleum Program. Four additional rounds of groundwater monitoring will be performed at this site to monitor benzene recently detected above applicable cleanup levels. Figure 6-2B shows the environmental conditions, including the location of wells and where benzene has been detected in groundwater at the Building 215 Area. If the benzene (or any other PCOCs) is not detected above applicable cleanup levels in any of the Building 215 Area monitoring wells, the groundwater monitoring will be complete, the wells will be destroyed in accordance with applicable laws and regulations, and the site closed with no further action.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38.

10.1.2 Sewer Lift Station No. 2

With the exception of collecting and analyzing an additional groundwater sample for metals from monitoring well 600GW108 in an upcoming routine groundwater sampling event, no further remedial actions are required for Sewer Lift Station No. 2. Although nickel was detected in a grab groundwater sample slightly above the marine water cleanup level, nickel is the only site COC and is not expected to be retained if subsequent sampling indicates that the nickel concentration is below the cleanup level. Figure 6-3 shows the environmental conditions at Sewer Lift Station No. 2.

10.1.3 Former Building 609 Area

No remedial actions are required for Former Building 609 Area. No COCs exist in soil or water at the site. Figure 6-4 shows the environmental conditions at Former Building 609 Area.

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not reflect fixed costs that are associated with remedial activities. For example, the calculated cost to collect 5 soil samples at a small excavation (bottom and 4 sides) does not account for the fixed costs to bring a technician to the site (i.e., the unit rates associated with collecting samples assumes 20 samples are collected in a full day). In the same way, the unit rates may not reflect economies of scale that could be achieved at very large sites. For example, the unit rates for construction or engineering tasks associated with remediation of large landfills on the order of 10,000 cubic yards or more may not take into account cost savings associated with consolidation of activities, coordination of multiple projects simultaneously, purchase rather than rental of equipment, or other variations in implementing remediation selected by the Trust, its contractors, or consultants. However, for purposes of this feasibility study level cost estimate, the unit rates and total site costs derived in Appendix E are appropriate for the selection of preferred remedies.

10.2 FORT SCOTT

Remedial alternatives for Battery Howe/Wagner, Building 1244 Area, Building 1245 Area, Building 1351 Area, Building 1369 Area, and Building 1388 Area are discussed in Sections 10.2.1 through 10.2.6.

10.2.1 Battery Howe/Wagner

Table 10-15 summarizes the detailed comparative analysis of potential remedial alternatives for Battery Howe/Wagner. The site is located north of Ruckman Avenue and west of Wagner Road. The plan area of Battery Howe/Wagner is approximately 1-½ acres with a ground surface that slopes gently to the east; that is, for every six feet in the horizontal direction the slope falls about one foot in the vertical direction ("6H:1V"). The relief is about 45 feet with a maximum elevation of 220 feet Presidio Lower Low Water ("PLLW") at the western portion of the site. The elevation at the eastern portion of the site is 175 feet PLLW. Figure 6-5B shows the environmental conditions at Battery Howe/Wagner.

Field observations and review of soil and groundwater analytical results obtained during the recent investigations by the Trust and previous sampling efforts by the Army indicate that the fill at Battery Howe/Wagner primarily consists of soil and relatively minor amounts of debris. While a few metals were detected above applicable cleanup levels in soil samples from test pit HWTP100 at 3 feet bgs and test pit HWTP104 at 10 feet bgs, the area of significant concern was encountered at test pit HWTP102 at and below 9 feet bgs. Borings and test pits at the site indicate that significant quantities of wood debris are present at depth within this portion of the landfill. Debris was not generally observed in the soil at depths less than three feet bgs.

Alternative 3, Maintain Existing Permeable Cover Over Waste and Monitor Water, is the preferred remedial alternative for Battery Howe/Wagner. This alternative involves maintaining the existing soil cover over the site and monitoring the water quality of groundwater and seeps at Battery Howe/Wagner. The objective of this alternative is to limit contact of fill by human and ecological receptors. Groundwater monitoring will be conducted to evaluate up gradient metals concentrations in groundwater relative to metals concentrations in groundwater downgradient of and at the Site. This evaluation will be limited to the review and reporting of groundwater monitoring data collected on a regular basis (quarterly, semi-annually, or annually). No extensive study of background metals in groundwater is included with this alternative, nor is it anticipated by the Trust to be necessary to meet remedial action objectives. For cost estimation purposes, it is assumed that groundwater monitoring will be required for 10 years to verify that debris in Battery Howe/Wagner does not pose a threat to groundwater.[34]

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[34] Consistent with U.S. EPA *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study,* dated July 2000, present worth of total estimated costs assume that annual costs will be experienced for 30 years for remedial alternatives that leave impacted soil and/or debris in place, because cover maintenance will require "perpetual care." Due to the unknown source of carbon tetrachloride in groundwater, cost estimates for Battery Howe/Wagner (Table E-5 series in Appendix E) assume that 10 years of groundwater monitoring will be performed for all active

Carbon tetrachloride ranging from 0.8 to 1.6 µg/L has been detected in monitoring well HWGW01. The cleanup level for carbon tetrachloride is 0.5 µg/L. As discussed in Section 6.2.1, carbon tetrachloride does not appear to be associated with the fill at Battery Howe/Wagner. The Trust detected carbon tetrachloride ranging from 0.6 to 2.7 µg/L in groundwater samples from monitoring well HWGW101, which is situated west, in the up gradient direction of groundwater flow of Battery Howe/Wagner. The Trust has investigated potential sources of this chemical, and no sources have been identified. Since the concentrations are slightly above cleanup levels and active remedial actions are not appropriate, the Trust anticipates ongoing monitoring of the carbon tetrachloride at Battery Howe/Wagner as part of the overall site remedy.

Cost estimates provided in Appendix E provide an outline for a conceptual groundwater monitoring plan, including the construction of five new groundwater monitoring wells (although fewer may be appropriate after consultation with regulatory agencies), and regular groundwater monitoring (quarterly, tapering to semi-annual and annual) for metals and VOCs. The new wells would be sampled after installation, and then included with the groundwater sampling program that includes the existing Battery Howe/Wagner groundwater monitoring wells. Land use controls to limit penetration of the existing cover include a site-specific addendum to the LUCMRR, as discussed in Section 8.3.2.1. An operations and maintenance plan to maintain the existing cover will include regular cover inspections. For cost estimating purposes, annual inspections are anticipated, with a five-year review that will include a topographical survey. Damage caused by subsidence or erosion will be repaired, as well as periodic breaches to the cover (such as utility construction or other major events). A report on remedy performance will be prepared at five-year intervals until regulatory agencies concur that five-year reviews are no longer needed.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38.

10.2.2 Building 1244 Area

Table 10-16 summarizes the detailed comparative analysis of potential remedial alternatives for the Building 1244 Area. Lead in soil has been detected above cleanup levels in a gravel-filled floor trench in Building 1244. No other COCs were identified in the Trust's investigation of the site. Figure 6-6B shows the environmental conditions at the Building 1244 Area.

Alternative 2, Excavate and Dispose of Soil Off-Site and No Action for Water, is the preferred remedial alternative for the Building 1244 Area. Under this alternative, impacted soil and gravel in the known areas with COCs greater than applicable cleanup levels will be excavated, transported, and disposed at an off-site, permitted waste management facility. Soil and gravel removal from the trench may be conducted after

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remedial alternatives, even those involving excavation and disposal of impacted soil and construction debris at an off-site, permitted facility.

the building is demolished. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for lead to verify cleanup levels are achieved. No groundwater impact is known or anticipated.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38. No annual costs are anticipated for this site.

10.2.3 Building 1245 Area

No remedial actions are required for Building 1245 Area. No COCs exist in soil or water at the site. Figure 6-6B shows the environmental conditions at the Building 1245 Area.

10.2.4 Building 1351 Area

Table 10-17 summarizes the detailed comparative analysis of potential remedial alternatives for the Building 1351 Area. Soil is known to be impacted with metals and petroleum hydrocarbons in the areas shown on Figure 6-7B.

Alternative 2, Excavate and Dispose of Soil Off-Site and No Action for Water, is the preferred remedial alternative for the Building 1351 Area. Under this alternative, impacted soil with COCs greater than applicable cleanup levels will be excavated, transported, and disposed at an off-site, permitted waste management facility. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for metals and petroleum hydrocarbons to verify cleanup levels are achieved. No groundwater impact is known or anticipated at this site.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38. No annual costs are anticipated for this site.

10.2.5 Building 1369 Area

No remedial actions are required for the Building 1369 Area. No COCs exist in soil or water at the site. Figure 6-8 shows the environmental conditions at the Building 1369 Area.

10.2.6 Building 1388 Area

No remedial actions are required for the Building 1388 Area. No COCs exist in soil or water at the site. Figure 6-9 shows the environmental conditions at the Building 1388 Area.

10.3 LETTERMAN COMPLEX

The preferred remedial alternatives for Fill Site 6, Building 1057, Building 1151/1153 Area, and Building 1167 Area are discussed in Sections 10.3.1 through 10.3.4.

10.3.1 Fill Site 6

Table 10-18 summarizes the detailed comparative analysis of potential remedial alternatives for Fill Site 6. The site has an irregularly shaped plan area of about 17 acres. Fill Site 6 is relatively flat with an average surface grade of about 2 percent to the north. Elevations range from about 50 feet PLLW at the southern portion of the site to about 10 feet PLLW at the northeast portion of the site. The site is in the vicinity of Lincoln Boulevard, Halleck Street, Girard Road, and many other traffic routes. At least six structures and numerous utility lines are located within the boundaries of the site.

Most of Fill Site 6 is covered by improvements such as parking lots, buildings, and landscaping. Only the area bounded by Girard Road, Halleck Street, Lincoln Boulevard, and Building 1030 is not fully covered (i.e., Fill Site 6A). PCBs and mercury were identified in soil samples from Fill Site 6A, as shown on Figure 6-10A. Alternative 5, Excavate, Recycle Waste and Segregate Soil, and Monitor Water, is the preferred remedial alternative for Fill Site 6A (i.e., see Figure 6-10B). Remedial alternatives analysis for Fill Site 6B will be included in a separate, future decision document. Alternative 5 entails excavating PCB-impacted soil in the mounded area between Lincoln Boulevard and Building 1030 to a depth of approximately 14 feet below grade, an estimated 23,000 cubic yards. Excavation on the east side of the mounded area, west of Girard Road, to a depth of 6 feet, is also included to address mercury detected above applicable cleanup levels. This area, located at the former building adjacent to Girard Road, is estimated to contain approximately 10,000 cubic yards, of which nearly 1,700 cubic yards is estimated to be concrete foundation material. For cost estimating purposes, the total volume of soil and debris to be excavated and removed under Alternative 5 is estimated to be 33,000 cubic yards. Excavated soil would be removed, debris screened, and soil disposed as non-hazardous waste. To the extent that recycling of material is not practicable, the fill material will be disposed off-site. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for PCBs and metals to verify cleanup levels are achieved. Grading will occur to provide a contoured area for the future riparian corridor.

Groundwater monitoring will be conducted to evaluate up gradient metals concentrations in groundwater relative to metals concentrations in groundwater downgradient of Fill Site 6A. This evaluation will be limited to the review and reporting of quarterly groundwater monitoring data. No extensive study of background metals in groundwater is included with this alternative, nor is it anticipated by the Trust to be necessary to meet remedial action objectives. For cost estimation purposes, it is assumed that groundwater monitoring will be required for 3 years to demonstrate that metals detected in soil at Fill Site 6A have not impacted groundwater.

Cost estimates provided in Appendix E provide an outline for conceptual groundwater monitoring plan, including the construction of four new groundwater monitoring wells up gradient and downgradient of Fill Site 6A (one of the new wells would replace existing well LF6GW102), and quarterly groundwater monitoring for three years for metals and general minerals. The new wells would be sampled after installation, and then included

with the groundwater sampling program for Fill Site 6A, which includes existing groundwater monitoring well LF6GW103.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38.

10.3.2 Building 1057

No remedial actions are required for Building 1057. No COCs exist in soil or water at the site. Figure 6-11 shows the environmental conditions at the Building 1057 site.

10.3.3 Building 1151/1153 Area

No remedial actions are required for the Building 1151/1153 Area. Residual PCBs in soil after the Army completed remedial actions in 1997 have been determined to pose no appreciable risk to human health and the environment. Figure 6-12B shows the environmental conditions at the Building 1151/1153 Area.

10.3.4 Building 1167 Area

Table 10-19 summarizes the detailed comparative analysis of potential remedial alternatives for the Building 1167 Area. Soil is impacted with metals in the area shown on Figure 6-13B. Alternative 2, Excavate and Dispose of Soil Off-Site and No Action for Water, is the preferred remedial alternative for the Building 1167 Area. Under this alternative, impacted soil with COCs greater than applicable cleanup levels will be excavated, transported, and disposed at an off-site, permitted waste management facility.

This alternative involves removal of soil within the known areas contaminated with arsenic and lead above applicable cleanup levels. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for arsenic and lead to verify cleanup levels are achieved. No groundwater impact is known.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38. No annual costs are anticipated for this site.

10.4 CAVALRY STABLES (PART OF PTMP'S CRISSY FIELD PLANNING DISTRICT)

The preferred remedial alternatives for Building 662 Area, Building 669 Area, and Building 680 Area are discussed in Sections 10.4.1 through 10.4.3.

10.4.1 Building 662 Area

Table 10-20 summarizes the detailed comparative analysis of potential remedial alternatives for the Building 662 Area. Surface soil is contaminated with metals near the

former locations of an underground storage tank and an aboveground storage tank. Figure 6-14B shows the environmental conditions at the Building 662 Area. Alternative 2, Excavate and Dispose of Soil Off-Site and No Action for Water, is the preferred remedial alternative for the Building 662 Area. Under this alternative, soil with COCs greater than applicable cleanup levels will be excavated, transported, and disposed at an off-site, permitted waste management facility. Implementation of this alternative will also complete the closure requirements for the two former waste oil tanks at the Building 662 Area.

This alternative involves removal of soil within the known areas contaminated with cadmium and lead above applicable cleanup levels. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for these metals to verify cleanup levels are achieved. No excavation in the location of the former underground storage tank is expected.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38. No annual costs are anticipated for this site.

10.4.2 Building 669 Area

Table 10-21 summarizes the detailed comparative analysis of potential remedial alternatives for the Building 669 Area. Figure 6-15B shows the environmental conditions at the Building 669 Area. As discussed in Section 6.4.2.2, additional investigation is needed to determine if metals other than lead or PAHs have impacted soil at this site. Alternative 2, Excavate and Dispose of Soil Off-Site and No Action for Water, is the preferred remedial alternative for the Building 669 Area. Under this alternative, soil with COCs greater than applicable cleanup levels will be excavated, transported, and disposed at an off-site, permitted waste management facility.

As part of the remedial design, soil samples will be collected to determine if other metals and PAHs are present above cleanup levels at the site. Additional sampling may be performed to confirm if the northern portion of the area of concern originates from former activities at Building 669 or from Doyle Drive.

This alternative involves removal of soil within the known areas contaminated with lead (and potentially other COCs) above applicable cleanup levels. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for lead (and potentially other COCs) to verify cleanup levels are achieved. Since Caltrans has already conducted a removal activity for lead adjacent to Doyle Drive, the Trust's remedial action will not extend into the area remediated by Caltrans (see Figure 6-15B).

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38. No annual costs are anticipated for this site.

10.4.3 Building 680 Area

No remedial actions are required for the Building 680 Area. Residual PCBs in soil after the Army completed remedial actions in 1997 have been determined to pose no appreciable risk to human health and the environment. Figure 6-16B shows the environmental conditions at the Building 680 Area.

10.5 EAST HOUSING

The preferred remedial alternatives for Landfill E, Fill Site 1, and El Polin Spring are discussed in Sections 10.5.1 through 10.5.3.

10.5.1 Landfill E

The detailed comparative analysis of potential remedial alternatives for Landfill E will be presented in the RAP for Landfill E or some other document, such as an addendum to this Presidio Trust Revised FS Report. The comparative analysis will incorporate the results of the Trust's field sampling event from the fall of 2002 and winter of 2002/2003. Figure 6-17C shows the environmental conditions at Landfill E.

10.5.2 Fill Site 1

Table 10-23 summarizes the detailed comparative analysis of potential remedial alternatives for Fill Site 1. The site covers a plan area of about 3½ acres and with a relief of about 40 feet. Trenching completed by the Trust in July 2000 indicates that the landfill requiring remedial actions may be approximately three-fourths of this area. The majority of the site is fairly flat with a 2 percent grade sloping south to north. The elevation of the top of the landfill is 160 feet and the elevation of the bottom of the landfill is 120 feet PLLW. The northwest face of Fill Site 1 is inclined about 3H:1V. Figure 6-18B shows the environmental conditions at Fill Site 1.

Alternative 4, Excavate, Recycle Waste and Segregate Soil, and Monitor Groundwater, is the preferred remedial alternative for this site. This alternative involves removing the impacted portion of the landfill by excavating the fill, segregating and recycling debris to the extent practicable, and transporting and disposing of soil that cannot be reused. The objective of this remedial alternative is to remove fill so some of the pre-existing drainage patterns can be re-created as part of the restoration of the Tennessee Hollow riparian corridor. To the extent that recycling of material is not practicable, then the fill material will be disposed off-site.

As discussed in Section 6.5.2.2, analytical results indicate that soil in the fill in the southern portion of Fill Site 1 does not contain significant chemical concentrations that would prohibit its reuse at the Presidio. Consequently, it is assumed that excavated fill will be screened to remove minor amounts of debris that may be present in soil. Separated debris will be recycled at an off-site facility and it is assumed that

approximately 70 percent of the segregated soil will be used as daily cover at an off-site, permitted waste management facility, while approximately 10 percent of the segregated soil may be classified as a non-RCRA hazardous waste based on detected concentrations of lead or other chemicals detected in the soil. It is assumed that the remaining 20 percent of segregated soil will be used to contour slopes at Fill Site 1 upon completing excavation of the fill.

Soil excavation will likely proceed from areas known to contain debris and COCs toward the areas that are not suspected to contain debris or COCs. Sidewall and bottom confirmation sampling for metals and pesticides will be conducted when no visual indications of impacted fill are found. If the confirmation samples indicate that no metals or pesticides are present above applicable cleanup levels, no further excavation will be performed. If metals or pesticides are present above applicable cleanup levels or debris is encountered, excavation will be continued. Excavation will be stopped if continued excavation would endanger the structural stability of any permanent buildings near Fill Site 1. Discussions with regulatory agencies will be initiated to evaluate options for leaving material in place with land use controls. Once excavation is complete, the sidewalls would be graded with segregated soil to contour the site. The shape and appearance of the slopes and contours will be addressed in the final remedial design, and will be a function of the amount of soil that is actually excavated.

Groundwater will be monitored to confirm that water quality in the area has not been adversely impacted. Cost estimates provided in Appendix E provide an outline for conceptual groundwater monitoring plan, including the abandonment of three existing wells that will be replaced with four new groundwater monitoring wells, and regular groundwater monitoring (quarterly, tapering to semi-annually) for metals and general minerals. The new wells would be sampled after installation, and then included in the existing Presidio groundwater monitoring program. Seep samples will also be collected on a regular basis. It is assumed for cost estimating purposes that groundwater and seep monitoring will be conducted for three years. The actual time that groundwater and seep monitoring is performed will be a function of analytical results.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38.

10.5.3 El Polin Spring

No remedial actions are required for El Polin Spring. Remedial actions to be implemented at Fill Site 1 and Landfill 2 will reduce the potential for contamination of the spring. Monitoring of the El Polin Spring area (three seep locations) is included with the remedial actions for Landfill 2 (Section 10.8.1). Figure 6-18B shows the environmental conditions at El Polin Spring.

10.6 CRISSY FIELD

The preferred remedial alternatives for Sewer Lift Station No. 1, Former Building 611 Area, and Building 633 Firing Range are discussed in Sections 10.6.1 through 10.6.3.

10.6.1 Sewer Lift Station No. 1

Table 10-24 summarizes the detailed comparative analysis of potential remedial alternatives for Sewer Lift Station No. 1. The RI identified a limited "hot spot" where concentrations of lead and zinc in shallow soil are greater than applicable cleanup levels. Figure 6-19B shows the environmental conditions at Sewer Lift Station No. 1. As discussed in Section 6.6.1, additional investigation is needed to confirm that metals have not significantly impacted groundwater at the site. Alternative 2, Excavate and Dispose of Soil Off-Site and No Action for Water, is the preferred remedial alternative for Sewer Lift Station No. 1. Under this alternative, impacted soil with COCs greater than applicable cleanup levels will be excavated, transported, and disposed at an off-site, permitted waste management facility.

The actual scope of the investigation at Sewer Lift Station No. 1 will be determined as part of the remedial design. For purposes of estimating costs associated with this remedial alternative, it has been assumed that six soil samples and one grab groundwater sample will be obtained to determine the lateral extent of COCs in soil and whether COCs are present in the groundwater below Sewer Lift Station No. 1. Two of the soil samples would be collected from the boring in which a grab groundwater sample is obtained. In addition, four shallow soil samples would be collected at the site. The grab groundwater sample would be filtered prior to testing. Soil and groundwater samples would be tested for metals.

Location of the borings will be based on previous data and ground surface topography that would have directed overflowing wastewater. Analytical data for metals collected from soil and groundwater samples will be compared to cleanup levels (Table 5-2). Soil above cleanup levels, if any, will be excavated, transported, and disposed at an off-site, permitted waste management facility. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for lead and zinc to verify cleanup levels are achieved. If chemicals are detected above applicable cleanup levels in groundwater, the Trust will evaluate whether installation of groundwater monitoring wells and limited groundwater monitoring is appropriate; this evaluation may include an assessment of up gradient concentrations of metals in groundwater relative to metals concentrations in groundwater at and downgradient of the site. If no groundwater impacts are identified above cleanup levels, no further action will be conducted for groundwater.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38. No annual costs are anticipated for this site.

10.6.2 Former Building 611 Area

No remedial actions are required for the Former Building 611 Area. No COCs exist in soil or water at the site. Figure 6-4 shows the environmental conditions at the Former Building 611 Area.

10.6.3 Building 633 Firing Range

Table 10-25 summarizes the detailed comparative analysis of potential remedial alternatives for the Building 633 Firing Range. Figure 6-20B shows the environmental conditions at the Building 633 Firing Range. Alternative 2, Excavate and Dispose of Soil Off-Site and No Action for Water, is the preferred remedial alternative for this site. This alternative involves excavating the sand and soil with COCs greater than cleanup levels, removing the concrete walls and floor of the firing range (as shown on Figure 6-20B), and transporting and disposing of the soil, sand, and debris at an off-site, permitted waste management facility. If the concrete structure is deemed to be historic, the concrete walls and floor of the firing range will not be demolished (only the soil and sand will be removed). If necessary, clean soil will be placed and compacted to restore the site grade that existed before excavation.

This alternative involves removal of soil and sand within the known areas contaminated with COCs (metals and PAHs) above applicable cleanup levels, as well as concrete removal if the structure is not historic. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for metals and PAHs to verify cleanup levels are achieved.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38. No annual costs are anticipated for this site.

10.7 PRESIDIO HILL (PART OF PTMP'S SOUTH HILLS PLANNING DISTRICT)

The preferred remedial alternatives for Graded Area 9, Mountain Lake, Nike Facility, Nike Swale, Former Building 302 Area, and Building 1450/1451 Area are discussed in Sections 10.7.1 through 10.7.6.

10.7.1 Graded Area 9

No remedial actions are required for Graded Area 9. No COCs were retained in soil or water at the site. The existing groundwater monitoring wells will be destroyed in accordance with applicable laws and regulations. Figure 6-21B shows the environmental conditions at Graded Area 9.

10.7.2 Mountain Lake

Table 10-26 summarizes the detailed comparative analysis of potential remedial alternatives for Mountain Lake. Sediment sampling by the Trust and others has identified the presence of metals, pesticides, and petroleum hydrocarbons above cleanup levels. Figure 6-22C shows the environmental conditions at Mountain Lake. Alternative 2, Excavate and Dispose of Soil Off-Site and No Action for Water, is the preferred remedial alternative for Mountain Lake. Dredging of lake sediments is viewed as a specific type of excavation and disposal; while the process of handling both liquid and solid phases is more complicated, the overall removal concepts are similar. Under this alternative, impacted sediment with metals greater than applicable cleanup levels will be excavated, transported, and disposed at an off-site, permitted waste management facility. The cost estimates include confirmation sampling of remaining sediments, which may be conducted if deemed appropriate (see discussion of confirmation sampling below). As agreed with DTSC, the detection of cadmium at less than ten times its cleanup level of 1.1 mg/kg will not drive additional remedial action. Pesticides, which are believed to originate from legal application, will also not drive remedial action at Mountain Lake.

Dredging or removal of sediment from water bodies can be categorized as either mechanical or hydraulic depending on the basic methods of moving the material that is dredged. Mechanical dredges offer the advantage of removing the sediment at nearly the same solids content as the in-place material. In other words, little additional water is entrained with the sediment as it is removed, meaning that the volume of sediment is essentially the same before and after dredging.

Actual removal operations will be coordinated with the Mountain Lake enhancement project. For example, the Mountain Lake Enhancement Plan also includes lake dredging (Trust, et. al., 2000a). For cost estimating purposes, EKI has assumed that the sediment in Mountain Lake has a solids content of 50 percent and a density of 1.7 tons per cubic yards of material removed. Solids content is defined as the mass of dry solids per mass of whole sediment (i.e., combined mass of water and dry solids). Solids content differs from the definition of moisture content, which is an engineering term that is determined as the mass of water in a sample divided by the mass of dry solids in the same sample. Sediment parameters assumed for Mountain Lake are based upon a general rule-of-thumb cited by U.S. EPA (1994a) that in-place, predominantly fine-grained, sediments have a solids content of approximately 50 percent, and Drevdahl (1963) who reports that moderately packed, wet mud has an in-place density that ranges from 2,970 to 3,510 pounds per cubic yard (1.5 to 1.8 tons per cubic yard).

The physical constraints surrounding Mountain Lake (e.g., limited access, presence of Park Presidio Boulevard immediately adjacent to the lake, the public park) make staging of equipment and stockpiling of dredged sediment at the site difficult. Further, Mountain Lake is only 10 feet deep at its deepest point, and the depth throughout most of the lake is between 3 and 6 feet deep (Beutel, 1997; Presidio Trust, et al., 2000). The lake's shallow water and limited access may restrict operation of conventional dredging equipment. Consequently, EKI has assumed that a backhoe placed upon a barge or floating platform

will be used to excavate the upper 2 feet of sediment that has been impacted with lead and other metals of concern. The material will be deposited into a pontoon boat or other vessel, which will convey the dredged material to the Mountain Lake shoreline. A second backhoe will be employed to transfer the sediment in the pontoon boat to roll-off bins or end-dump trucks that have been sealed to prevent against leakage of water entrained in the sediment. The waste would likely be transported to a staging area at the Presidio or off-site that can accommodate dewatering and temporary staging of the waste and where segregation and testing can be accomplished during remedial actions. Ultimately, material placed in bins or end-dump trucks will be transported to appropriate off-site, permitted facilities for treatment and disposal. Although sediment reuse is proposed in the Mountain Lake Enhancement Plan (Trust, et. al., 2000a), for cost estimating purposes, off-site disposal for all removed sediment is assumed in the cost estimate for Mountain Lake remedial actions (Appendix E).

Of the area shown on Figure 6-22C, approximately half of the 6,000 cubic yards of sediment presently estimated to contain lead and other metals at concentrations greater than applicable freshwater sediment cleanup levels may have to be disposed as a RCRA hazardous waste. A geotechnical study may also be performed as part of remedial design to confirm that dredging will not compromise the stability of the underpinning for Park Presidio Boulevard. No expenses for shoring or other actions to protect structures and improvements near Mountain Lake have been assumed in the cost estimate for Alternative 2.

Samples of sediments remaining in place may be obtained after dredging to confirm that impacted sediment has been significantly removed. Although care will be taken to minimize suspension of contaminated material, the limitations inherent in employing dredging for cleanup may result in the situation where some confirmation samples still contain lead or other metal concentrations that are above freshwater sediment cleanup levels. Regarding the limitations of dredging, U.S. EPA (1994a) states the following:

> …planners and designers should not develop unrealistic expectations of dredging accuracy. Contaminated sediments cannot be removed with surgical accuracy even with the most sophisticated equipment. Equipment is not the only factor affecting the accuracy of a dredge. Site conditions (e.g., weather, currents), sediment conditions (e.g., bathymetry, physical character), and the skill of the dredge operator are all important factors. In addition, the distribution of sediment contaminants can, in many cases, only be resolved at a crude level and with substantial margin for error. The level of accuracy required for environmental dredging should reflect the accuracy at which the sediment contamination distribution is resolved.

Although confirmation sampling for known COCs (metals, pesticides, and petroleum hydrocarbons[35]) has been included in the cost estimate, dredging to predetermined limits

[35] As discussed in Section 6.7.2.2, TPH as diesel results may represent naturally occurring organic compounds. Any confirmation sampling should be subjected to silica gel clean up prior to analysis to remove any naturally-occurring organic matter.

or use of bivariate scatter plots and other statistical measures may be more appropriate to evaluate if the remedial action has adequately achieved applicable cleanup levels.

The storm drain drop inlets within Park Presidio are not included within the scope of this remedial action. The Trust views the maintenance of and environmental contamination from releases from drop inlets in a Caltrans right-of-way as a Caltrans issue.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38. No annual costs are anticipated for this site.

10.7.3 Nike Facility

Table 10-27 summarizes the detailed comparative analysis of potential remedial alternatives for Nike Facility. Sediment that contains metals, PAHs, PCB, and petroleum hydrocarbons at concentrations greater than applicable cleanup levels exist in subsurface drains and ditches at the site. Figure 6-23C shows the environmental conditions at the Nike Facility. As discussed in Section 6.7.3.2, additional investigation is needed (1) to confirm that surface soil at Nike Facility does not contain metals, PAHs, PCB, and petroleum hydrocarbons that might act as an ongoing source of contamination, and (2) to characterize the western drainage ditch. Alternative 2, Excavate and Dispose of Soil Off-Site and Monitor Water, is the preferred remedial alternative for Nike Facility. Under this alternative, impacted surface soil and sediment in the subsurface drains and ditches with COCs greater than applicable cleanup levels, including material identified through additional sampling, will be excavated, transported, and disposed at an off-site, permitted waste management facility. Groundwater monitoring is also included in this alternative.

As discussed in Section 6.7.3.3, the Army identified a small amount of petroleum in soil that was left in place after the Army's removal actions at the Nike Facility (IT Corporation, 1999c). This small volume of sand (estimated to total one cubic yard) is not anticipated to be a significant source of chemicals to the groundwater, and therefore no additional attempts to remove this material are included in this alternative.

The actual scope of the investigation at Nike Facility will be determined as part of the remedial design. The Trust anticipates sampling near the storm drain inlets and along the western drainage ditch parallel to Battery Caulfield Road; prior characterization has been limited to PAHs only. For purposes of estimating costs associated with this remedial alternative, it has been assumed that twelve shallow soil samples will be obtained to characterize these additional areas. These collected soil samples would be analyzed for metals, PAHs, PCB, and petroleum hydrocarbons.

Analytical data collected from the sediment and soil samples will be compared to applicable cleanup levels (Tables 5-2 and 5-5). Sediment or soil above cleanup levels, if any, will be excavated, transported, and disposed at an off-site, permitted waste management facility. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for metals, PAHs, PCBs, petroleum hydrocarbons, and any other identified COCs to verify cleanup levels are achieved. Regular groundwater

monitoring (quarterly, tapering to semiannually) for metals at five existing groundwater monitoring wells is also included in this alternative. It is assumed that three years of monitoring will be sufficient to demonstrate that previous remedial actions conducted by the Army have mitigated impacts, if any, to groundwater.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38.

10.7.4 Nike Swale

Table 10-28 summarizes the detailed comparative analysis of potential remedial alternatives for Nike Swale. At Nike Swale, cadmium, PCBs, and PAHs are retained as COCs. The PCBs and PAHs probably reflect sediment that was conveyed with storm water runoff in the ditches from Nike Facility. Cadmium was detected above applicable cleanup levels at one location. The detected cadmium is likely attributable to background levels. Figure 6-24B shows the environmental conditions at the Nike Swale.

Alternative 4, Excavate and Dispose of Soil Off-Site and No Action for Water, is the preferred remedial alternative for Nike Swale. Alternative 4 will entail better characterization of the extent of PCB- and PAH-containing soil and excavating the impacted soil from Nike Swale to permanently eliminate the contaminated material. Under this alternative, known impacted soil with PCBs or PAHs greater than applicable cleanup levels, as well as any additional soil or sediment identified through additional sampling, will be excavated, transported, and disposed at an off-site, permitted waste management facility. Removal of soil will require close coordination with Trust and NPS natural resource staff to minimize damage to the sensitive habitat.

The alternative includes the collection of an estimated 32 soil characterization samples. . The samples will be collected by hand auger and analyzed for metals, PCBs, and PAHs. Analytical data collected from soil samples will be compared to applicable cleanup levels (Tables 5-2 and 5-3). Based on the results of the data, it is anticipated that additional soil identified above cleanup levels, if any, will be excavated, transported, and disposed at an off-site, permitted waste management facility. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for PCBs and PAHs (and any other COCs identified during sampling) to verify cleanup levels are achieved. In addition, verification samples for metals will be collected during the remedial design at the location of soil sample NSSB104, where cadmium was detected above applicable cleanup levels (Figure 6-24A). The objective of the sampling is to verify the presence of cadmium and evaluate if it may actually be naturally occurring (e.g., through the use of bivariate scatter plots and other statistical methods). No COCs exist in water at the site.

If the new data indicate that a significant portion of the Nike Swale would be excavated, the Trust may choose to re-evaluate the impact of the excavation on sensitive plant species.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38. No annual costs are anticipated for this site.

10.7.5 Former Building 302 Area

No remedial actions are required for the Former Building 302 Area. No COCs exist in soil or water at the site. Figure 6-25 shows the environmental conditions at the Former Building 302 Area.

10.7.6 Building 1450/1451 Area

No remedial actions are required for the Building 1450/1451 Area. No COCs exist in soil at the site. Groundwater at this site is addressed as part of the Nike Facility (see Section 10.7.3). Figure 6-26 shows the environmental conditions at the Building 1450/1451 Area.

10.8 PRESIDIO FOREST (PART OF PTMP'S SOUTH HILLS PLANNING DISTRICT)

The preferred remedial alternatives for Landfill 2, Landfill 4, and the Transfer Station Area are discussed in Sections 10.8.1 through 10.8.3.

10.8.1 Landfill 2

Table 10-29 summarizes the detailed comparative analysis of potential remedial alternatives for Landfill 2. The plan area of the site is about 2 acres with a relief of about 100 feet. The elevation of the top of the landfill is 250 feet PLLW and the elevation of the bottom of the landfill is 150 feet PLLW. The ground surface slopes to the northeast with an average inclination of about 4H:1V. The site is overgrown with vegetation and trees. Figure 6-27B shows the environmental conditions at Landfill 2.

Alternative 4, Excavate, Recycle Waste and Segregate Soil, and Monitor Groundwater, is the preferred remedial alternative for this site. This alternative involves completely removing the landfill by excavating the fill, segregating and recycling debris to the extent practicable, and transporting and disposing of contaminated soil and debris that cannot be recycled at an off-site, permitted waste management facility. To the extent that recycling of material is not practicable, then the fill material will be disposed off-site. The objective of this remedial alternative is to remove fill so pre-existing drainage patterns can be created as part of the restoration of the Tennessee Hollow riparian corridor.

Soil excavation will likely proceed from areas known to contain debris and COCs toward the areas that are not suspected to contain debris or COCs. Sidewall and bottom confirmation sampling for metals and pesticides will be conducted when no visual indications of impacted fill are found. If the confirmation samples indicate that no metals or pesticides are present above applicable cleanup levels, no further excavation will be

performed. If metals or pesticides are present above applicable cleanup levels or debris is encountered, excavation will be continued. Once excavation is complete, the sidewalls will be graded to contour the site to limit erosion. The shape and appearance of the slopes and contours will be addressed in the final remedial design and will be a function of the amount of soil that is actually excavated.

If sufficient space is available, excavated waste will be temporarily staged at the site to segregate debris from contaminated soil for recycling at off-site facilities (if practicable), and to allow testing to classify contaminated soil for proper disposal. More likely, the waste would be transported to an area at the Presidio or off-site that can accommodate temporary staging of the waste where segregation and testing can be accomplished. Based upon available analytical results, a significant percentage of the soil and sediment at Landfill 2 may have to be classified and disposed as non-RCRA hazardous waste (estimated at 55% of the volume) or RCRA hazardous waste (estimated at 10% of the volume) at an off-site, permitted facility.

Excavation equipment would likely access Landfill 2 by Quarry Road. Access to the landfill may impact the serpentine grasslands and sensitive habitats that abut Quarry Road. The remedial design will identify specific limitations to the remediation contractor to minimize damage to the serpentine grasslands and other sensitive habitats in the area. Removal of trees will be required to excavate Landfill 2. It is anticipated that tree cutting will be coordinated with Trust and NPS natural resource staff to avoid potential disruption to nesting or migrating birds.

Groundwater will be monitored to confirm that water quality in the area has not been adversely impacted. Two new groundwater monitoring wells are proposed to be installed after the landfill is excavated. Quarterly monitoring for metals, VOCs, TPH as diesel, TPH as fuel oil, and general minerals analysis of the seeps downhill of Landfill 2 , including El Polin Spring, and five groundwater monitoring wells is included in the annual cost estimate for the Landfill 2 remedy. It is assumed for cost estimating purposes that groundwater monitoring will be conducted for three years. The actual time that groundwater monitoring is performed may differ.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38.

10.8.2 Landfill 4

Landfill 4 is addressed in a separate RAP (Treadwell & Rollo, 2002c), which includes evaluation and selection of remedial alternatives. Implementation of remedial activities at Landfill 4 began in late autumn of 2002. Figure 6-28B shows the environmental conditions at Landfill 4.

10.8.3 Transfer Station Area

Table 10-31 summarizes the detailed comparative analysis of potential remedial alternatives for the Transfer Station Area. Figure 6-29B shows the environmental conditions at the Transfer Station Area. As discussed in Section 6.8.3, additional investigation is needed to identify all of the areas of concern and determine the volume of COC-containing soil at this site. Alternative 2, Excavate and Dispose of Soil Off-site and No Action for Groundwater, is the preferred remedial alternative for the Transfer Station Area. Under this alternative, known impacted soil with COCs greater than applicable cleanup levels, along with additional soil identified through sampling, if any, will be excavated, transported, and disposed at an off-site, permitted waste management facility. Clean soil will be placed and compacted to restore the site grade that existed before excavation. Rubbish dumped along the slope northeast of the Transfer Station will also be removed and properly disposed at an off-site facility.

The actual scope of the investigation at the Transfer Station Area will be determined as part of the remedial design. For purposes of estimating costs associated with this remedial alternative, it has been assumed that twenty-four shallow soil samples will be obtained to determine the extent of COCs in soil. These collected soil samples would be analyzed for metals, pesticides, and PAHs.

Analytical data collected from the soil samples will be compared to applicable cleanup levels (Tables 5-2 and 5-5). Soil above cleanup levels, along with any additional soil identified during through additional characterization sampling, will be excavated, transported, and disposed at an off-site, permitted waste management facility. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for metals, pesticides, and PAHs to verify cleanup levels are achieved.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38. No annual costs are anticipated for this site.

10.9 LOBOS CREEK VALLEY

The preferred remedial alternatives for the Building 1750 Area and Lobos Creek are discussed in Sections 10.9.1 and 10.9.2.

10.9.1 Building 1750 Area

No remedial actions are required for the Building 1750 Area. No COCs have been detected in soil at the site and no groundwater impact is anticipated. No further action is required for the Building 1750 Area. Figure 6-30 shows the environmental conditions at the Building 1750 Area.

10.9.2 Lobos Creek

No remedial actions are required for Lobos Creek. No COCs exist in sediment at the site and lead and arsenic in surface water are likely naturally occurring. No further action is required for Lobos Creek. Figure 6-31 shows the environmental conditions at Lobos Creek.

10.10 COASTAL BLUFFS

Preferred remedial alternatives for Fill Site 5 and Baker Beach Disturbed Areas 1A, 1, 2, 3, and 4 are discussed in Sections 10.10.1 through 10.10.6.

10.10.1 Fill Site 5

Fill Site 5 is addressed in a separate RAP (Treadwell & Rollo, 2002c), which includes evaluation and selection of remedial alternatives. Implementation of remedial activities at Fill Site 5 began in late autumn of 2002. Figure 6-32B shows the environmental conditions at Fill Site 5.

10.10.2 Baker Beach Disturbed Area 1A

Table 10-33 summarizes the detailed comparative analysis of potential remedial alternatives for Baker Beach Disturbed Area 1A. The site is situated between Battery Cranston and Battery Marcus Miller. The site lies on a west-facing slope between elevations of about 190 feet and 175 feet PLLW above the Pacific Ocean. Access to this site is difficult. Figure 6-33B shows the environmental conditions at Baker Beach Disturbed Area 1A.

Alternative 2, Excavate and Dispose of Soil Off-site and No Action for Water, is the preferred remedial alternative for Baker Beach Disturbed Area 1A. This alternative involves excavating the tar-permeated debris and soil with an assumed extent shown on Figure 6-33B, and transporting and disposing of this debris at an off-site, permitted waste management facility. The area will not be backfilled. The objective of this remedial action is to remove the roofing debris and PAHs in soil at concentrations greater than applicable cleanup levels. No water has been observed or is anticipated at this site.

Prior to excavation, samples of the debris will be collected and analyzed to determine if asbestos is present. If so, applicable regulations to address removal of asbestos containing materials will be implemented. Based upon discussions with DeSilva Gates, access limitations will likely require use of a small excavator (e.g., Bobcat) to remove the debris and impacted soil at Baker Beach Disturbed Area 1A. Excavated debris and soil will be transported and disposed at an off-site, permitted waste management facility. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for PAHs to verify cleanup levels are achieved. It is anticipated that coordination with GGBHTD will be necessary since the easiest access to Baker Beach

Disturbed Area 1A appears to be through GGBHTD's vehicle storage and maintenance yard.

Potential effects that the remedial actions may have on nesting birds and rare plants in the area must be evaluated. Protocols for protecting historic batteries and fortifications will need to be established. The Coastal Trail, a popular footpath at the Presidio, crosses Baker Beach Disturbed Area 1A, which may affect site access. Consideration of how remedial actions will affect use of the Coastal Trail is also required. However, no direct cost for the relocation or other actions for the Coastal Trail are included in this estimate.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38. No annual costs are anticipated for this site.

10.10.3 Baker Beach Disturbed Area 1

Table 10-34 summarizes the detailed comparative analysis of potential remedial alternatives for Baker Beach Disturbed Area 1. The site is located between Battery Marcus Miller and Battery Boutelle and extends to within 40 feet of the Pacific Ocean. The landfill has a plan area of about 2 acres and is situated on steep west-facing bluffs. The relief of Baker Beach Disturbed Area 1 is just over 210 feet. Ground surface inclinations average 1.5H:1V. The elevation of the top of the landfill is 220 feet PLLW and the elevation of the bottom of the landfill is 10 feet PLLW. The steep slopes complicate access to Baker Beach Disturbed Area 1. Figure 6-34B shows the environmental conditions at Baker Beach Disturbed Area 1.

Alternative 3, Excavate, Recycle Waste and Segregate Soil, and Monitor Groundwater, is the preferred remedial alternative for this site. This alternative involves completely removing the landfill by excavating the fill, segregating and recycling debris to the extent practicable, and transporting and disposing of contaminated soil and sediment that cannot be recycled at an off-site, permitted waste management facility. To the extent that recycling of material is not practicable, then the fill material will be disposed off-site. The objective of this remedial alternative is to remove fill so serpentine habitats can be restored. Surface water and seeps will be monitored to confirm that water quality in the area has not been adversely impacted.

The coastal bluffs' steep slopes make excavating fill at Baker Beach Disturbed Area 1 very difficult. Based upon discussions with Golder and DeSilva Gates, one possible approach for consolidating fill for its removal involves securing a bulldozer to a winch at the top of the slope. The secured bulldozer would push fill from the edges of the landfill and create mounds of waste in the center of Baker Beach Disturbed Area 1. Temporary fencing would be erected along the beach to prevent fill that may fall from the slopes from entering the Pacific Ocean. Temporary fencing would also safeguard recreational users on the beach from potential injury caused by falling debris.

A drag line excavator could be positioned at the top of the slope to collect the waste piled into mounds. A drag line excavator is a crane that is equipped with a bucket that is

manipulated by cables. The drag line excavator would carry the waste to the top of the slope where it would be transferred into end-dump trucks and transported to an area at the Presidio or off-site that can accommodate temporary staging of the waste. The waste would be temporarily staged to segregate debris from contaminated soil and sediment (if practicable) for recycling at off-site facilities, and to allow testing to classify contaminated soil and sediment for proper disposal. Based upon available analytical results, a large percentage of the soil and sediment at Baker Beach Disturbed Area 1 may have to be classified and disposed as non-RCRA hazardous waste at an off-site, permitted facility. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for metals, VOCs, PCBs, and pesticides to verify cleanup levels are achieved.

Actual procedures for implementing the preferred remedial alternative may vary from those described in the Presidio Trust Revised FS Report. The manner in which remedial actions are performed at Baker Beach Disturbed Area 1 will depend upon the remedial design of the alternative, the approach of the Trust's selected contractor, and the composition of fill and physical conditions encountered at the site. Potential effects that the remedial actions may have on nesting birds and rare plants in the area must be evaluated. It is anticipated that tree cutting will be coordinated with Trust and NPS natural resource staff to avoid potential disruption to nesting or migrating birds. Protocols for protecting historic batteries and fortifications will need to be established. The Coastal Trail, a popular footpath at the Presidio, crosses Baker Beach Disturbed Area 1. Consideration of how remedial actions will affect use of the Coastal Trail is also required. However, no direct cost for the relocation or other actions for the Coastal Trail are included in this estimate.

A surface water seep has been sampled at the site. The cost estimate assumes the seep will be monitored regularly for metals, SVOCs, pesticides, PCBs, and general minerals as part of the site remedy. It is assumed for cost estimating purposes that seep monitoring will be conducted for three years. The actual time that seep monitoring is performed will be a function of analytical results and presence of water at the seep.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38.

10.10.4 Baker Beach Disturbed Area 2

Table 10-35 summarizes the detailed comparative analysis of potential remedial alternatives for Baker Beach Disturbed Area 2. The plan area of the site is about 1½ acres in two distinct areas with a relief of approximately 225 feet. A relatively flat surface that is currently used as a parking lot exists at the crest of the bluffs in the eastern portion of Baker Beach Disturbed Area 2. The elevation of the top of the landfill is 260 feet PLLW and the elevation of the bottom of the landfill is 20 feet PLLW. The ground surface slopes steeply to the west ranging from 2.5H:1V to as steep as 1.5H:1V. Access to this site is very difficult. Figure 6-35B shows the environmental conditions at Baker Beach Disturbed Area 2.

Alternative 3, Excavate, Recycle Waste and Segregate Soil, and No Action for Water, is the preferred remedial alternative for this site. This alternative involves completely removing the landfill by excavating the fill, segregating and recycling debris to the extent practicable, and transporting and disposing of contaminated soil and sediment that cannot be recycled at an off-site, permitted waste management facility. To the extent that recycling of material is not practicable, then the fill material will be disposed off-site. The objective of this remedial alternative is to remove fill so serpentine habitats can be restored. No surface water sampling is included under this alternative because seeps have not been observed at Baker Beach Disturbed Area 2.

Additional investigation is needed to determine the extent of debris at the northern area of Baker Beach Disturbed Area 2. This alternative includes the collection of six soil samples that will be analyzed for metals, pesticides, PAHs, and PCBs. Impacted soil with COCs greater than applicable cleanup levels, if any, identified through sampling will be excavated, transported, and disposed at an off-site, permitted waste management facility with the other soil and debris from the southern portion of Baker Beach Disturbed Area 2.

The actual scope of the investigation at the Baker Beach Disturbed Area 2 will be determined as part of the remedial design. Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for metals, pesticides, and PAHs (and any other COCs identified during sampling) to verify cleanup levels are achieved.

It is assumed that excavation of fill at Baker Beach Disturbed Area 2 will be performed with a bulldozer and drag line excavator, as described for Baker Beach Disturbed Area 1 in Section 10.10.3. Actual procedures for implementing the preferred remedial alternative may vary from those described in the Presidio Trust Revised FS Report. The manner in which remedial actions are performed at Baker Beach Disturbed Area 2 will depend upon remedial design of the alternatives, the approach of the Trust's selected contractor, and the composition of fill and physical conditions encountered at the site. Many of the same concerns identified for Baker Beach Disturbed Area 1 will need to be addressed for Baker Beach Disturbed Area 2. These concerns include the potential effects that remedial actions may have on nesting birds and rare plants, historic batteries and fortifications, and crossing the Coastal Trail, which all exist in the area.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38. No annual costs are anticipated for this site.

10.10.5 Baker Beach Disturbed Area 3

Table 10-36 summarizes the detailed comparative analysis of potential remedial alternatives for Baker Beach Disturbed Area 3. The approximate plan area of the site is about 3½ acres with a relief of about 205 feet. The elevation of the top of the landfill is 250 feet PLLW and the elevation of the bottom of the landfill is 50 feet PLLW. The ground surface slopes west with inclinations ranging from 10H:1V to as steep as 1H:1V.

Figure 6-36B shows the environmental conditions at Baker Beach Disturbed Area 3. Investigation by the Trust of the upper portion of this site indicates that chemicals are less than applicable cleanup levels and no debris is present in the fill. The upper portion of Baker Beach Disturbed Area 3 appears to consist of soil that was imported to stabilize Lincoln Boulevard. No remedial actions are warranted for the upper portion of Baker Beach Disturbed Area 3. In addition, sensitive habitat has been identified in the upper portion of Baker Beach Disturbed Area 3.

Debris is found in fill in the lower portion of Baker Beach Disturbed Area 3 that is primarily west of the trail to Battery Crosby. Metals, pesticides, and PCBs have been detected at concentrations greater than cleanup levels at some locations within this lower portion of the site. Alternative 4, Excavate, Recycle Waste and Segregate Soil, and Monitor Groundwater, is the preferred remedial alternative for the lower portion of Baker Beach Disturbed Area 3. This alternative involves completely removing the landfill by excavating the fill, segregating and recycling debris to the extent practicable, and transporting and disposing of contaminated soil and sediment that cannot be recycled at an off-site, permitted waste management facility. To the extent that recycling of material is not practicable, then the fill material will be disposed off-site. The objective of this remedial alternative is to remove fill so native plant habitats can be restored. Monitoring the water quality of seeps and groundwater at the site is also included in the remedy.

It is assumed that excavation of fill at Baker Beach Disturbed Area 3 will be performed with common earth moving equipment, although the terrain is quite steep. Based upon discussions with Golder and DeSilva Gates, common bulldozers and possibly scrapers may be used to excavate the landfill. Actual procedures for implementing the preferred remedial alternative may vary from those described in the Presidio Trust Revised FS Report. The manner in which remedial actions are performed at Baker Beach Disturbed Area 3 will depend upon remedial design of the alternatives, the approach of the Trust's selected contractor, and the composition of fill and physical conditions encountered at the site. Many of the same concerns identified for Baker Beach Disturbed Areas 1 and 2 will need to be addressed for Baker Beach Disturbed Area 3. These concerns include the potential effects that remedial actions may have on nesting birds and rare plants, and public beach access, which all exist in the area.

Soil excavation will likely proceed from areas known to contain debris and COCs toward the areas that are not suspected to contain debris or COCs. Sidewall and bottom confirmation sampling for metals, pesticides, and PCBs will be conducted when no visual indications of impacted fill are found. If the confirmation samples indicate that no metals, pesticides, or PCBs are present above applicable cleanup levels, no further excavation will be performed. If metals, pesticides, or PCBs are present above applicable cleanup levels or debris is encountered, excavation will be continued. Once excavation is complete, the sidewalls will be graded to contour the site to limit erosion. The shape and appearance of the slopes and contours will be addressed in the final remedial design, and will be a function of the amount of soil that is actually excavated.

If sufficient space is available, waste will be temporarily staged at the site to segregate debris from contaminated soil (if practicable) for recycling at off-site facilities, and to allow testing to classify contaminated soil for proper disposal. More likely, the waste will be transported to an area at the Presidio or off-site that can accommodate temporary staging of the waste where segregation and testing can be accomplished.

Excavation of Baker Beach Disturbed Area 3 could potentially disturb sensitive plant habitat in the upper portion of the landfill. Procedures for minimizing damage to this habitat will need to be established as part of the remedial design. Removal of trees will be required to excavate Baker Beach Disturbed Area 3. It is anticipated that tree cutting will be coordinated with Trust and NPS natural resource staff to avoid potential disruption to nesting or migrating birds.

A surface water seep has been sampled at the site. The cost estimate assumes the seep will be monitored regularly for metals, pesticides, PCBs, and general minerals as part of the site remedy. Three groundwater monitoring wells are proposed to be installed at Baker Beach Disturbed Area 3. It is assumed for cost estimating purposes that seep and groundwater monitoring will have to be conducted for three years. The actual time that seep and groundwater monitoring is performed will be a function of analytical results.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38.

10.10.6 Baker Beach Disturbed Area 4

Table 10-37 summarizes the detailed comparative analysis of potential remedial alternatives for Baker Beach Disturbed Area 4. The site has an irregularly shaped plan area of approximate ½ acre and runs directly beside Lincoln Boulevard. The relief of Baker Beach Disturbed Area 4 is about 70 feet with an average ground surface inclination of about 3.5H:1V. However, some sections of the fill at the southern portion of the site are as steep as about 1.25H:1V. No surface water has been encountered or is anticipated at this site. Figure 6-37B shows the environmental conditions at Baker Beach Disturbed Area 4.

Testing conducted by the Trust in July and August 2000 indicates that the fill used to support Lincoln Boulevard and Chamberlin Road at this site is structural soil. Alternative 2, Excavate and Dispose of Soil Off-site and No Action for Water, is the preferred remedial alternative for Baker Beach Disturbed Area 4. This alternative involves excavating the “hot spot” area shown on Figure 6-37B, and transporting and disposing of this soil at an off-site, permitted waste management facility. Clean soil will be placed and compacted to restore the site grade that existed before excavation and maintain structural integrity of Chamberlin Road. The objective of this remedial action is to remove the isolated concentrations of lead, zinc, and pesticides that appear to be present in soil at concentrations greater than applicable cleanup levels.

Soil excavation will likely proceed from areas known to contain lead, zinc, and pesticides above cleanup levels toward the areas that are not suspected to contain these chemicals (e.g., along the surface drainage feature). Confirmation samples from the excavation bottom and sidewalls will be collected and analyzed for lead, zinc, and pesticides to verify cleanup levels are achieved. Once excavation is complete, the excavation will be backfilled to maintain structural integrity of Chamberlin Road and to limit erosion.

Estimated costs for the alternatives for this site and preferred remedy are presented in Table 10-38. No annual costs are anticipated for this site.

11. SUMMARY OF PREFERRED ALTERNATIVES

Main Installation sites considered in the Presidio Trust Revised FS Report consist of eleven landfills and twenty-eight miscellaneous sites. Preferred remedial alternatives identified by the Trust are listed in Table 11-1. Included in this table are the key components of remedial actions for each Main Installation site, and the preliminary estimated present worth of capital, annual, and total costs, assuming a real discount rate of 3.9 percent. For those sites where annual costs will be experienced, the project life of a remedy is assumed to be 3, 10, or 30 years as noted in Table 11-1. These project lives are estimates only and the actual duration of the remedy may vary substantially from those assumed. Figure 11-1 depicts the locations of the Main Installation sites at the Presidio and identifies the type of remedial actions that comprise the preferred alternative for each site.

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