**DEPARTMENT OF THE NAVY**
NAVAL FACILITIES ENGINEERING COMMAND SOUTHWEST
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132-5190

5090
Ser OPCE.TM/667
October 4, 2005

Ms. Beatrice Griffey
California Environmental Protection Agency
California Regional Water Quality Control Board
Mitigation & Cleanup Unit
9174 Sky Park Court, Suite 100
San Diego, Ca 92123-4340

Mr. Tayseer Mahmoud
California Environmental Protection Agency
Department of Toxic Substance Control
Office of Military Facilities
5796 Corporate Avenue
Cypress, CA 90603

Mr. Martin Hausladen
U.S. Environmental Protection Agency
Region IX, Code SFD-8-B
75 Hawthorne Street
San Francisco, CA 94105-3901

Dear Ms. Griffey, Mr. Mahmoud, and Mr. Hausladen:

This letter transmits the "Draft Final Operable Unit 5 Feasibility Study for Sites 1A-1, 1111 & 12 Area, Site 13, Marine Corps Base Camp Pendleton, California." Per section 7.2(a) of the Federal Facilities Agreement (FFA), this document becomes final 30 days from receipt if dispute resolution is not invoked or is not modified by decision of the dispute resolution process.

This document is being sent six days later than the original schedule to allow for the resolution of one remaining issue raised by the DTSC. This issue was resolved and incorporated into this document. No changes have been made to Appendix A at this time.

Should you have questions, please call me at (619) 532-1502.

Sincerely,

Theresa L Morley

THERESA L. MORLEY
Lead Remedial Project Manager
By direction of the
Commanding Officer

5090
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October 4, 2005

Copy to: Commanding General
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# APPENDIX A

## MILESTONES AND SCHEDULES

(Revised, August 18, 2005)

**Milestones and Schedules for OU 4**

| | |
|---|---|
| Draft ROD (P) | 2/28/06 |

**Milestones and Schedules for OU 5**

| | |
|---|---|
| Draft Proposed Plan (P) | 1/19/06 |
| Draft ROD (P) | 11/23/06 |

***DRAFT FINAL***

# OPERABLE UNIT 5 FEASIBILITY STUDY FOR SITES 1A-1, 1111, AND 12 AREA, SITE 13 MARINE CORPS BASE CAMP PENDLETON, CALIFORNIA

*Prepared For*

NAVAL FACILITIES ENGINEERING COMMAND - SOUTHWEST DIVISION
1220 Pacific Highway, San Diego, CA 92132-5190

*GSA Contract Number GS-10F-0179J*
*Delivery Order No. N68711-00-F7907*

September 29, 2005

*Prepared by*

**PARSONS**
100 West Walnut Street
Pasadena, California 91124

***DRAFT FINAL***

# OPERABLE UNIT 5 FEASIBILITY STUDY FOR SITES 1A-1, 1111, AND 12 AREA, SITE 13 MARINE CORPS BASE CAMP PENDLETON, CALIFORNIA

*Prepared For*

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September 29, 2005

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# EXECUTIVE SUMMARY

This report presents the results of the Feasibility Study (FS) for four sites within Operable Unit (OU) 5 at the Marine Corps Base Camp Pendleton, California (MCB Camp Pendleton or the Base). This report was prepared for the Naval Facilities Engineering Command, Southwest Division (SWDIV) under Government Services Agreement (GSA) Contract Number GS-10F-0179J, Delivery Order Number N68711-00-F7907.

Delivery of this document is pursuant to the MCB Camp Pendleton Federal Facilities Agreement (FFA) between the U.S. Environmental Protection Agency (USEPA), the California Environmental Protection Agency, Department of Toxic Substances Control (Cal/EPA DTSC), the San Diego Regional Water Quality Control Board (RWQCB), and the Department of the Navy (DON). The FFA establishes a framework for implementing appropriate environmental response actions at the Base.

The purpose of the remedial investigation/feasibility study (RI/FS) is to assess site conditions and evaluate alternatives to the extent necessary to select a remedy. The primary objective of the feasibility study is to ensure that appropriate remedial alternatives are developed and evaluated such that relevant information concerning the remedial action option can be presented to a decision-maker and an appropriate remedy selected.

The following sites are addressed in this document:

- Site 1A-1 – Refuse Disposal Area adjacent to Site 1A
- Site 1111 – Burn Ash and Refuse Disposal Area
- 12 Area, Site 13 – Former Mess Hall and UST

Site 6A is part of OU 5 but was not evaluated in this FS because it was recommended for No Further Action based on the results of the remedial investigation (Parsons, 2004a). Site 21 was included in the Draft FS (Parsons, 2005a), but it was decided during the 24 May 2005 FFA Meeting that additional data were required prior to completing the FS; therefore it is not included in this Draft Final FS. Two other OU 5 sites, Site 33 and 13 Area Force Service Support Group (FSSG) Lot, are not included in this FS Report because it was agreed by the FFA Team that additional field data need to be collected at those sites prior to completing a feasibility study. These sites will be addressed in a separate RI and FS. Also, 22/23 Area Groundwater, although part of OU 5, is being addressed separately to allow for additional data collection to define the presence of 1,2,3-trichloropropane (TCP) above the state action level.

Chemicals of potential concern (COPCs) present in soils at Sites 1A-1 and 1111 are primarily metals, dioxins, pesticides, and volatile organic compounds (VOCs). Contaminants present in groundwater at Sites 21, 1111, and 12 Area, Site 13 are primarily VOCs. This document summarizes past and recent field investigation results. Detailed discussion of each site investigation is provided in the Draft Final OU 5 RI Report (Parsons, 2004). Based on the data, conclusions, and risk assessments presented in the RI Report for each site, various potential remedial approaches are screened in this FS, which results in a set of remedial alternatives for each site.

For the OU 5 sites with soil contamination, remedial goals (RGs) were used to develop and evaluate the remedial alternatives. The RG for each remedial chemical of concern

(COC) was selected from preliminary RGs based on risk to human health, ecological receptors, and groundwater. For human health protection, the preliminary RGs were derived using the same exposure and toxicity criteria as outlined in the OU 5 RI Report. Site- and chemical-specific preliminary RGs were also developed for ecological receptors in accordance with exposure and effects data used in the OU 5 RI Report. A vadose zone fate-and-transport analysis was used to determine the preliminary RGs of remedial COCs that can remain in soil and still be protective of groundwater. The lowest of the three preliminary RGs (i.e., human health, ecological, or threat to groundwater) or background value was then selected as the proposed RG for the remedial COCs in soil.

Groundwater RGs that were used to develop remedial alternatives are based on either cleanup to drinking water standards (maximum contaminant levels [MCLs] or background), or risk-based standards for protection of downgradient receptors, depending on whether the site meets the standards for beneficial use.

The FS provides an analysis of the remedial alternatives available to clean up soil and groundwater to the RGs. It provides the information needed by decision-makers to select the best technically and economically feasible alternative to achieve the remedial action objectives (RAOs). Consistent with this approach, this FS focuses on cost-benefit issues such as risk reduction and impacts to beneficial use. However, it does not define final cleanup levels nor does it include an analysis aimed at selecting the final remedy. These decisions will be made during the Proposed Plan and Record of Decision (ROD) stages.

The FS findings and proposed remedial alternatives are summarized below for each site.

## ES.1 SITE 1A-1

Site 1A-1 is an ash and debris disposal area approximately 1.5 acres, located 750 feet north-northeast of Installation Restoration (IR) Site 1A in the 14 Area. Site 1A is immediately northeast of Base Sewage Treatment Plant No. 1. Pilgrim Creek Trail runs along the eastern boundary of the site. Pilgrim Creek is located east and south of the site.

Site 1A-1 has visible surface debris, and was confirmed as a former waste disposal area, probably associated with the nearby Site 1A. Field investigations have found Site 1A-1 to contain waste material and ash up to 10 feet thick.

Site 1A-1 is no longer in operation, and military and civilian personnel cross the site infrequently because the vegetation is relatively dense. The surrounding areas are undeveloped and classified as maneuver areas. The nearest troop housing is approximately 0.25 mile southwest. The nearest family housing, De Luz Housing, is approximately 1.5 miles north.

The likelihood of future residential land use is considered low, given current development plans and current land use in the vicinity of the site. The nearest groundwater production wells to Site 1A-1 are over four miles downgradient from the site in the San Luis Rey River Basin. Two production wells (Well 4 and Well 5) in the San Luis Rey River Valley are located near the intersection of North River Road and College Boulevard (City of Oceanside, July 2004). Future use of groundwater is considered improbable, given the limited saturated thickness of alluvium near the site.

Although Site 1A-1 is directly adjacent to Pilgrim Creek, a streambed with intermittent flow, no perennial surface water is present. The area receives low annual rainfall, primarily during the winter months.

Site 1A-1 is within a north-south trending valley referred to as Pilgrim Creek Valley. This generally V-shaped valley consists of consolidated igneous bedrock partly filled with unconsolidated alluvium (streambed sediments) Groundwater is present in the Pilgrim Creek streambed sediments (unconsolidated Quaternary alluvium). Depth of groundwater below ground surface (bgs) within the streambed was approximately 12.5 feet at the time of field investigation, although the water table in the Pilgrim Creek Valley is known to fluctuate based on historical data from monitoring wells at the nearby Site 1A. Groundwater is not present in the bedrock underlying most of the waste fill soils.

Site 1A-1 is located within the known foraging area of nesting coastal California gnatcatchers. Biological resource monitoring may be required during any potential site remediation and/or further investigation activities if conducted during the breeding season.

Site 1A-1 soil contaminants likely originated from the disposal of waste materials onto an accessible open area near Site 1A.

The following conclusions were reached for Site 1A-1 in the OU 5 RI:

- The volume of impacted soils is approximately 20,000 cubic yards, with a thickness of up to 10 feet, and the spatial extent is approximately 1.5 acres. Field mapping, subsurface data collected during drilling, and analytical data were used to define the lateral and vertical extent of contamination. Analytical testing and field observations do not indicate the presence of debris in the Pilgrim Creek streambed.
- Some metals (primarily lead, iron, and arsenic), dioxins/furans, and organochlorine pesticides (4,4-dichlorodiphenyldichloroethane [DDD], 4,4-dichlorodiphenyldichloroethene [DDE], and 4,4-dichlorodiphenyltrichloroethane [DDT]) are present in the waste soils above their industrial-soil PRGs.
- The highest concentrations of DDT/DDD/DDE are present in the southern portion of the site. The lateral and vertical extent of the elevated pesticide levels appears to be limited.
- Although no visible debris is present in the streambed, trace concentrations of chemicals of potential concern (COPCs) in the sediment samples indicate erosion of waste materials may have had a minor impact to streambed sediments directly adjacent to waste material. Future erosion of waste materials could continue to impact streambed sediments to a more significant extent than currently observed.
- Groundwater is not present directly beneath most of the waste soils. The nearest groundwater is in the Pilgrim Creek streambed, adjacent to the waste fill. Modeling indicates that benzene may pose a threat to groundwater, although no contamination was detected in the downgradient groundwater monitoring well. Given the relatively long time frame since the placement of waste soils, significant leaching of benzene at detectable concentrations in groundwater is considered unlikely.
- The site is currently vacant and undeveloped with no plans for development given its location within an ecologically sensitive area. Military training receptors may occasionally be present in this area although the duration spent in any one location would likely be minimal and the potential for contact with impacted soils relatively low

- Although the predicted reasonable maximum exposure (RME) risk to a hypothetical nonintrusive worker ($2 \times 10^{-4}$) is at the upper end of the USEPA risk management range (USEPA, 1991b), the site is considered to be protective of human health given the conservative nature of the evaluation and the low potential for development. An institutional control limiting site development may be necessary.
- Lead concentrations in soil at Site 1A-1 ranged up to 9,670 milligrams per kilogram (mg/kg). The 95 percent upper confidence level (UCL) mixed (0 to 10 feet bgs) and surface (0 to 1.5 feet bgs) soil exposure point concentration of 1,200 mg/kg is within the default preliminary remediation goal (PRG) range of 780 to 1,200 mg/kg.
- The ecological risk assessment concluded that baseline conditions are not protective of ecological receptors at the site. Based on the site-specific tiered ecological risk assessment for Site 1A-1, four chemicals are present in soil at concentrations that are predicted to pose a potentially significant hazard to specific ecological receptors: antimony (invertebrate feeding [invertivorous] birds), lead (invertivorous and omnivorous birds), zinc (insectivorous birds), and dioxins (birds and small mammals). Potentially significant ecological hazards are indicated if concentrations of a chemical at the site result in the estimation of a Tier-2 hazard quotient with a value greater than 1.0. The highest values of the Tier-2 effect-based hazard quotients are 2.3 (insectivorous birds exposed to antimony), 10 (invertivorous birds exposed to lead), 2 (insectivorous birds exposed to zinc), and 64 (omnivorous mammals exposed to dioxins). For other chemicals evaluated in Tier 2 (a total of 37), all Tier-2 effect-based hazard quotients for birds and mammals are less than 1.0. In addition, while there are concentrations of some inorganic chemicals that result in Tier-2 hazard quotients greater than one for terrestrial plant receptors, and for soil organisms and microbial processes, these Tier-2 hazard quotients still rely on Tier-1-level toxicity data (i.e., no-effect toxicological benchmarks).
- Coastal California gnatcatchers were observed at Site 1A-1, and therefore biological resource monitoring may be required during any potential site remediation and/or further investigation activities if conducted during the breeding season.

A technology screening and subsequent evaluation of selected process options were performed to identify potential remedial measures that would be effective in addressing the observed soil contamination. Based on this evaluation, the following alternatives were developed and evaluated in this FS:

Alternative 1A1-1: No Action

Alternative 1A1-2: Institutional Controls

This alternative restricts land use to ensure protection of human health and the environment by controlling and monitoring exposure pathways. The site would be inspected periodically for evidence of erosion. If required, measures would be implemented to limit or control site erosion.

Alternative 1A1-3: Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls

This alternative consists of an engineered soil cover, (i.e., an evapotranspiration [ET] cover), annual monitoring, operations and maintenance (O&M), and institutional controls. This alternative includes construction of an approximately 1.5-acre ET cover system. The cap would be designed to provide long-term minimization of infiltration of liquids, function with minimum maintenance, and promote proper drainage. The implementation of appropriate mitigation measures and coordination with the U.S. Fish and Wildlife Service (USFWS) would be required to minimize and avoid habitat disruptions during all site activities.

Alternative 1A1-4: Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal

This alternative addresses remediation of contaminated soils through excavation, on-Base stabilization, and off-Base disposal. The following elements are associated with Alternative 1A1-4:

- Excavation of impacted soil
- Treatment of a portion of the excavated soil to incorporate chemical stabilizer (Portland cement Type I through V or other appropriate stabilizing agent) by pug mill
- Temporary storage of excavated soil stockpiles
- Sampling and analysis of soil stockpiles for waste characterization
- Transportation of the excavated soil to an off-Base disposal facility
- Confirmation sampling and analysis of excavation areas
- Import and compaction of backfill material
- Site restoration.

Following excavation to the necessary lateral limits and target depths, confirmation samples would be collected for laboratory analysis. Confirmation sampling would be performed shortly after excavation has been completed, so that, to the extent possible, sampling would be performed concurrent with excavation.

As described in the OU 5 RI Report, potential human receptors evaluated in the risk assessment for the soil pathways were 1) intrusive worker, 2) nonintrusive worker, and 3) military trainee. The RGs developed in Section 2.2.3 pertain to these same receptor scenarios. If all waste soil is excavated from Site 1A-1, however, it is possible that the resulting residual COCs at the site, after excavation, may not pose a risk to a hypothetical resident. Although there is no anticipated future residential land use at the site at this time, it may be desirable to obtain an unrestricted land use designation following excavation if little additional excavation is required. If it is decided to attempt to document unrestricted land use following removal of waste soils, it will be necessary to calculate risk to human health based on residual concentrations reported in confirmation samples. Such calculations can be conducted "real-time" during site remediation. Although this procedure is not necessary to achieve cleanup to the RGs established in this FS, the project decision-makers can determine if this would be a beneficial exercise during site cleanup if this remedial alternative were chosen. In other words, it may be worth a relatively small additional effort during remediation to achieve an unrestricted land use if soils are excavated.

The results of the comparative analysis for Site 1A-1 are summarized below.

| Criteria | Alternative | | | |
|---|---|---|---|---|
| | 1A1-1[a] | 1A1-2[b] | 1A1-3[c] | 1A1-4[d] |
| **Threshold Criteria** | | | | |
| Overall Protection of Human Health and the Environment | No | No[e] | Yes | Yes |
| Compliance with ARARs | No | No | Yes | Yes |
| **Balancing Criteria** | | | | |
| Long-Term Effectiveness and Permanence | Low | Low | Moderate to High | High |
| Reduction of Toxicity, Mobility, or Volume by Treatment | Low | Low | Low | Moderate |
| Short-Term Effectiveness | Not Rated | High | Moderate | Moderate |
| Implementability | Not Rated | Moderate | Moderate | High |
| Cost ($ million) | 0 | 0.30 | 2.58 | 8.06 |

[a] No Action
[b] Institutional Controls
[c] Capping with Engineered Soil Cover and Institutional Controls
[d] Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal
[e] Institutional controls would be protective of human health but not protective of ecological receptors

Alternative 1A1-1 does not meet applicable or relevant and appropriate requirements (ARARs) and would not be protective of the environment. Alternative 1A1-1 also does not provide long-term effectiveness and permanence. No costs are associated with Alternative 1A1-1.

Alternative 1A1-2 would be protective of human health through use restrictions but would not be protective of ecological receptors. The potential for longer term adverse ecological impacts is increased due to the site's vulnerability to flooding, which could mobilize or expose subsurface soil contamination that is not currently available for contact with ecological receptors.

Alternatives 1A1-3 and 1A1-4 would be protective of human health and the environment, meet ARARs, and provide a high degree of long-term effectiveness and permanence. Alternative 1A1-3 provides long-term effectiveness through elimination of exposure pathways via capping. Alternative 1A1-4 would be the only alternative for which reduction of toxicity, mobility, or volume by treatment would be demonstrated, via some pretreatment prior to disposal. Alternative 1A1-4 has the highest ranking for implementability.

The cost to reduce the ecological risks and exposure pathways associated with site metals, with restricted land use, is estimated to be $295,000 for Alternative 1A1-2. To achieve a higher level of protectiveness and unrestricted future land use, Alternative 1A1-3 would require overall costs of approximately $2,575,000 and Alternative 1A1-4 overall costs of approximately $8,062,600.

A possible fifth alternative for this site is being considered by the Navy, but is not included as a formal alternative in this document at this time pending further review and analysis. The fifth alternative, if determined to be feasible, would involve combining the waste soils from Site 1A and Site 1A-1 and capping the combined waste. If determined to be viable, a supplemental FS would be necessary, which would be reviewed by the FFA Team.

## ES.2 SITE 1111

Site 1111 is an ash and burn debris disposal area located in the 26 Area, approximately 8 miles northeast of the main gate and 1,600 feet northwest of Vandergrift Boulevard. COCs present at the site include numerous organic and inorganic contaminants, including antimony, mercury, hexachlorobenzene, and dioxins, and arsenic. The site is adjacent to the former Site 3 Pest Control Wash Rack, a Group A site documented in the Group A RI Report (SWDIV, 1993a) Soil excavation and disposal was conducted at adjacent Site 3 in 1997

The presence of burn debris extending down to the groundwater table, approximately 5 to 9 feet below ground surface, poses a continued threat to groundwater. Various organic and inorganic compounds are present in site groundwater above tap water PRGs and MCLs. The site is located in an ecologically sensitive area suitable for use by the least Bell's vireo, endangered under both the state and federal Endangered Species Acts, and southwestern arroyo toad, endangered under federal Endangered Species Act and considered a California species of concern.

Site 1111 is not currently used for any military or civilian activity, and future land use will likely remain the same. The nearest downgradient in-service Base production well, 10S/04W-07R02, is located 1,850 feet southwest of the site. An upgradient groundwater production well, 10S/04W-07H02, is located 1,300 feet north of the site. Both wells are in service. Current analytical results and fate-and-transport analysis indicate that site-related groundwater contamination has not migrated, and is not projected to migrate, to the Base production wells.

The following conclusions were reached for Site 1111 in the OU 5 RI Report:

- The total volume of soil that has been impacted by contaminants that pose a threat to human health and the environment is estimated to be approximately 1,100 cubic yards. These impacted soils are referred to as the burn debris area, or source area.
- Groundwater has been impacted by contaminants exceeding MCLs, including tetrachloroethene (PCE) and trichloroethene (TCE). Benzene was not detected during the 2003 sampling event. The highest contaminant concentrations in groundwater are observed in proximity to the known burn debris area, which also has the highest detections of COCs in soil.
- Nine vadose zone contaminants in the source area at Site 1111 exceed their maximum allowed leachate concentrations and pose a continuous threat to groundwater. Based on fate-and-transport modeling, volatile organic compounds (VOCs) in groundwater have reached a steady state condition with concentrations above MCLs reaching a maximum distance of 200 feet, and detectable concentrations reaching a maximum distance of 400 feet from the source area. Biodegradation plays a role in plume stability.
- Chlorinated compounds pose the greatest risk of migrating away from the source area. The nearest downgradient in-service Base production well, 10S/04W-07R02, is located 1,850 feet southwest of the site. Site 1111 is within the capture zone of this well (SWDIV, 1993).
- The site does not currently pose a threat to human health because there are no receptors. However, there would be a potential adverse risk under hypothetical future use of the site.

- The cumulative RME risk to a nonintrusive worker was estimated to be $1 \times 10^{-5}$. The corresponding RME risk to an intrusive worker was $6 \times 10^{-6}$. The maximum route-specific hazard index for both the RME nonintrusive worker and the RME intrusive worker were estimated to be less than the USEPA's target hazard index (HI) of one.
- Lead concentrations at Site 1111 ranged up to 19,000 mg/kg. The 95 percent UCL mixed (0 to 10 feet bgs) and surface (0 to 1.5 feet bgs) soil exposure point concentration of 96 and 380 mg/kg, respectively, are within the default USEPA (1996b) industrial soil PRG range of 780 to 1,200 mg/kg.
- Although it is unlikely that a water production well would ever be constructed and screened in the shallow groundwater at Site 1111, the RME risk to a hypothetical adult domestic water user, based on default exposure assumptions and USEPA toxicity factors, was estimated to be $2 \times 10^{-3}$.
- The ecological risk assessment concluded that baseline conditions are not protective of ecological receptors at the site. Based on the site-specific tiered ecological risk assessment, four chemicals are present in soil at concentrations that are predicted to pose a potentially significant hazard to specific ecological receptors: antimony (birds and small mammals), mercury (herbivorous and omnivorous small mammals), dioxins (herbivorous and omnivorous small mammals), and hexachlorobenzene (omnivorous small mammals)

A technology screening and subsequent evaluation of selected process options were performed to identify potential remedial measures that would be effective in addressing both the soil and groundwater contamination. Based on this evaluation, the following alternatives were developed and evaluated in this FS:

For soils:

Alternative 1111-S1: No Action

Alternative 1111-S2: Institutional Controls

This alternative would restrict future land use at the site and limit site access by enforcing land use restrictions. The site would be inspected periodically for evidence of erosion. If required, measures would be implemented to limit or control site erosion.

Alternative 1111-S3: Soil Excavation, Backfill, and Off-Base Disposal

This alternative involves removal of contaminated soils by excavation and off-Base disposal. The alternative description includes logistical details such as the need for confirmation sampling to ensure removal of soils exceeding remedial goals.

The results of the comparative analysis for soil at Site 1111 are summarized below.

| Criteria | Alternative | | |
|---|---|---|---|
| | 1111-S1[a] | 1111-S2[b] | 1111-S3[c] |
| **Threshold Criteria** | | | |
| Overall Protection of Human Health and the Environment | No | No[d] | Yes |
| Compliance with ARARs | No | No | Yes |
| **Balancing Criteria** | | | |
| Long-Term Effectiveness and Permanence | Low | Low | High |
| Reduction of Toxicity, Mobility, or Volume by Treatment | Low | Low | Low |

| Criteria | Alternative | | |
|---|---|---|---|
| | 1111-S1[a] | 1111-S2[b] | 1111-S3[c] |
| Short-Term Effectiveness | Not Rated | High | Moderate |
| Implementability | Not Rated | Moderate | High |
| Cost ($ million) | 0 | 0.30 | 0.71 |

[a] No Action
[b] Institutional Controls
[c] Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal
[d] Institutional controls would be protective of human health but not protective of ecological receptors

Alternative 1111-S1 does not meet ARARs and would not be protective of the environment. Alternative 1111-S1 also does not provide long-term effectiveness and permanence. No costs are associated with Alternative 1111-S1.

Alternative 1111-S2 would be protective of human health through use restrictions but would not be protective of ecological receptors. The potential for longer term adverse ecological impacts is increased due to the site's vulnerability to flooding, which could mobilize or expose subsurface soil contamination that is not currently available for contact with ecological receptors.

Alternative 1111-S3 would be protective of human health and the environment, meet ARARs, and provide a high degree of long-term effectiveness and permanence. Alternative 1111-S3 has the highest ranking for implementability.

The cost to reduce the ecological risks and exposure pathways associated with site metals, with restricted land use, is estimated to be $295,000 for Alternative 1111-S2. To achieve a higher level of protectiveness and unrestricted future land use, Alternative 1111-S3 would require overall costs of approximately $711,400.

For Groundwater:

Alternative 1111-G1: No Action

Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring and Alternative 1111-S3

This alternative involves soil source removal (Alternative 1111-S3) followed by institutional controls and long-term groundwater monitoring, and relies on effective implementation of administrative control measures to ensure that affected groundwater would not be used in the future, thereby maintaining the current lack of exposure to, and risks from, groundwater contaminants. Groundwater monitoring would ensure that groundwater contamination does not migrate further, toward the downgradient production well in the Santa Margarita River basin (10S/04W-07R02, located approximately 1,850 feet southwest of the site) Groundwater monitoring would also ensure that groundwater contamination does not adversely impact any production wells and/or nearby surface water bodies. The source area soil removal should enhance the effectiveness of this remedy.

Two new wells would be required, one to assess current conditions within the source area, and one to provide for a sentry well at a designated downgradient point between the plume boundary and production well 10S/04W-07R02 in the Santa Margarita Groundwater Basin. If the RG is exceeded at this sentry well, then additional analysis and/or remedial measures would be implemented to protect the downgradient production well.

Based on the Natural Attenuation Software (NAS) calculations, it would take approximately 3.4 years to reach MCLs and 4.9 years for background provided the source of contamination has been removed as included in Alternative 1111-S3. For cost estimating purposes, it is assumed that monitoring would be conducted semiannually for the first 2 years and annually for years 3 through 5.

Alternative 1111-G3: Monitored Natural Attenuation with Alternative 1111-G2

This alternative involves soil source removal (Alternative 1111-S3), the institutional controls, and limited groundwater monitoring to ensure that there is no downgradient migration of contaminated groundwater (Alternative 1111-G2), and a long-term monitoring program to document the performance and effectiveness of natural attenuation processes to contain and degrade groundwater contaminants. The logistics associated with the implementation of this alternative would be addressed in a Remedial Action/Monitored Natural Attenuation (MNA) Work Plan for the site. The success of this alternative relies on the ability of natural subsurface physical and biological attenuation processes (e.g., dispersion, degradation, sorption, and volatilization) to control plume expansion and reduce VOC concentrations to acceptable levels within a reasonable timeframe. Probability of successful MNA of groundwater is considered high, particularly because this alternative includes removal of the known soil source (Alternative 1111-S3). The estimated timeframe to achieve MCLs or background in groundwater is 3.4 years or 4.9 years, respectively.

The overall objectives of the performance monitoring for MNA at Site 1111 include:

- Demonstrate that natural attenuation is occurring according to expectations.
- Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other) that may reduce the efficacy of natural attenuation processes.
- Identify any potentially toxic and/or mobile transformation by-products.
- Verify that the plume is not expanding.
- Verify there is no unacceptable impact to downgradient receptors.
- Demonstrate the efficacy of institutional controls to protect potential receptors.
- Verify attainment of remediation objectives.

MNA would include collection of site-specific monitoring data to demonstrate continued reduction in the total mass of contaminants in groundwater over time. MNA quantitative models would be used to help understand site processes, locate monitoring points, estimate attenuation rates, and evaluate the effects changing conditions on MNA effectiveness. The plan would comply with USEPA guidance for performance monitoring of MNA remedies for VOCs in groundwater (USEPA, 2004a).

Alternative 1111-G4: Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3

Alternative 1111-G4 is a minor variation of Alternative 1111-G3 that combines all of the elements of the latter with the added element of enhanced in situ bioremediation to further reduce the concentrations of chlorinated aliphatic hydrocarbon (CAH) compounds in groundwater in the source area and expedite cleanup. Removal of contaminated soil will be performed as described under Alternative 1111-S3 (Section 3.6.2.3). A layer of

bark mulch, or other solid organic substrate, will be backfilled into the portion of the excavation that will be in contact with the groundwater, and the remaining portion of the excavation will be backfilled with clean soil. This alternative is designed to eliminate a continuing contaminant source by removal of the burn area, and to provide indigenous microorganisms with an additional source of organic carbon and hydrogen in the form of organic substrate to promote more anaerobic conditions in the aquifer. Based on the flexibility of this procedure and the relatively low concentrations of groundwater contaminants, a field treatability study would not be required prior to implementation. The probability of successful MNA of groundwater is considered high, particularly because this alternative includes removal of the known soil source (Alternative 1111-S3).

It is assumed that groundwater monitoring, which would include the same monitoring wells as described for Alternative 1111-G3, would be required for 2.6 years for MCLs and 4.1 years for background following excavation and treatment.

The results of the comparative analysis for groundwater at Site 1111 are summarized below.

| Criteria | Alternative | | | |
|---|---|---|---|---|
| | 1111-G1[a] | 1111-G2[b] | 1111-G3[c] | 1111-G4[d] |
| **Threshold Criteria** | | | | |
| Overall Protection of Human Health and the Environment | No | Yes | Yes | Yes |
| Compliance with ARARs | No | Yes | Yes | Yes |
| **Balancing Criteria** | | | | |
| Long-Term Effectiveness and Permanence | Low | Moderate | Moderate | Moderate to High |
| Reduction of Toxicity, Mobility, or Volume by Treatment | Low | Moderate | Moderate | Moderate to High |
| Short-Term Effectiveness | Low | Moderate | Moderate | Moderate to High |
| Implementability | Not Rated | High | High | High |
| Cost ($ million) | 0 | MCLs: $0.19 Background: $0.20 | MCLs: $0.27 Background: $0.31 | MCLs: $0.31 Background: $0.35 |
| **Remedial Timeframe** | | | | |
| Time to Achieve MCLs (years) | 50 | 3.4 | 3.4 | 2.6 |
| Time to Achieve background levels (years) | 50 | 4.9 | 4.9 | 4.1 |

[a] No Action.
[b] Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3.
[c] Monitored Natural Attenuation with Alternative 1111-G2.
[d] Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3

Alternative 1111-G1 is not protective of human health; does not meet ARARs; provides little short- or long-term effectiveness and permanence; achieves no reduction in toxicity, mobility, or volume through active treatment; and has no associated cost.

Alternatives 1111-G2 would provide adequate protection of human health and the environment and comply with ARARs but would not comply with ARARs in a reasonable timeframe. Alternative 1111-G2 provides short-term effectiveness and ease of implementation, but it does not provide removal of the source of the groundwater

contamination. This alternative would provide the monitoring necessary to track plume movement, as well as the necessary restrictions to limit exposure to the site contaminants. Alternatives 1111-G3 and 1111-G4 would provide adequate protection of human health and the environment and would comply with ARARs. Alternative 1111-G2 is the least expensive alternative.

Alternative 1111-G3 would provide a high degree of long-term effectiveness and permanence by reaching MCLs sooner and a decreased remediation time because the source would have been removed. Alternative 1111-G4 would provide a higher degree of long-term effectiveness and permanence by reaching MCLs sooner; the highest reduction in toxicity, mobility, or volume through treatment; and a somewhat decreased remediation time. For both alternatives 1111-G2 and 1111-G3, groundwater contaminants are estimated to reach RGs in about 3.4 to 4.9 years and for 1111-G4, groundwater contaminants are estimated to reach RGs in about 2.6 to 4.1 years. Alternative 1111-G4 would provide a cost-effective treatment alternative to the passive options provided by Alternatives 1111-G2 and 1111-G3.

## ES.3 12 AREA, SITE 13

The 12 Area, Site 13 is a former mess hall location in the eastern portion of MCB Camp Pendleton, approximately three miles southwest of the northeastern Base entrance, and approximately 500 feet west-southwest of the intersection of Vandergrift Boulevard and 19th Street. The 12 Area, Site 13 was formerly managed under the Base UST Program. As documented in the FFA Meeting Minutes for the 29 August 2000 meeting (No. 59), it was decided that due to the presence of VOCs in groundwater at the site, it would be addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program in OU 5.

Site 13 is currently undeveloped except for a segment of paved road. The site is sparsely vegetated with low-lying grasses and several trees on the eastern portion.

Groundwater is the only significantly impacted medium at the site. Benzene, toluene, ethylbenzene, and total xylenes (BTEX) and chlorinated compounds are present in shallow groundwater at concentrations exceeding MCLs. Most of the contamination is located at the former underground storage tank (UST) location. The concentrations of remedial COCs in the shallow groundwater are benzene (up to 11 micrograms per kilogram [µg/L]), and TCE (up to 10 µg/L). BTEX compounds are also present in deep groundwater at concentrations above MCLs, with the highest concentration detected at S13-MW15 (benzene at 1.3 µg/L).

The groundwater production wells closest to the site are located over 10,000 feet downgradient to the west within the Santa Margarita River basin, near Site 1111. The site is over 1 mile outside the Santa Margarita River basin and is over two miles east of the nearest water supply wells in 26 Area. The site is located approximately one mile southeast of Lake O'Neill, which is within the upper subbasin of the Santa Margarita River basin.

Monitoring wells at the site intercept both a limited perched zone, and a deeper groundwater zone. The groundwater flow direction in the shallow aquifer is toward the east, mimicking site topography, and the flow direction in the deep zone is to the west, similar to the prevailing southwestern dip of the underlying sedimentary bedrock. Perched groundwater is discontinuous, extending only to the eastern edge of the site.

The groundwater present below the 12 Area would not be considered a potential source of drinking water based on an analysis of site conditions relative to SWRCB Resolution

88-63. The average total dissolved solids (TDS) value based on geochemical data from 12 deep wells sampled in January 2002 and March 2003 is approximately 9,688 mg/L, with a minimum and maximum of 4,550 and 12,000 mg/L, respectively

Aerobic conditions in the groundwater outside the source zone appear to be allowing the low BTEX concentrations in these areas to biodegrade. TCE concentrations also appear to be stable through natural attenuation factors other than biodegradation (e.g., dilution/dispersion).

Conditions in the deeper zone appear to be aerobic TCE concentrations are low and are likely attenuating by dilution/dispersion processes even though anaerobic reductive dechlorination is not likely occurring Since the deeper zone is even more aerobic than the shallow zone, any petroleum compounds impacting the deep aquifer are rapidly degrading.

Given the land-use designations, land-use plans, and lack of complete exposure pathways, 12 Area, Site 13 does not constitute suitable foraging habitat for ecological resources and there is no contact between potential receptors and contaminated groundwater. Lacking complete exposure pathways, this area does not need to be considered further in the ecological risk assessment (ERA) process.

The following conclusions were reached regarding 12 Area, Site 13 in the OU 5 RI Report:

- Site groundwater contains contaminants, primarily BTEX and TCE, at concentrations up to 11 µg/L (higher concentrations of benzene were reported in 2001 data, but these data are not consistent with prior and subsequent data and are considered anomalous).
- No COPCs were detected in the new upgradient perched-zone monitoring well west of the site, so an off-site upgradient source to the west is considered unlikely.
- No COPCs were detected in the new downgradient deep monitoring well west of the site, so off-site migration to the west is considered unlikely.
- Based on historical site data, there is no evidence of a significant residual source of soil contamination at the site. However, minor residual free product is present that will serve as a continued source of dissolved VOCs to the groundwater.
- Based on further evaluation of hydrogeologic conditions at the site, a significant factor controlling the transport of VOCs to the east in shallow groundwater is the perched nature of the aquifer. Perched groundwater was not encountered in the area of deep wells S13-MW17 or S13-MW21. Steeper groundwater gradients coupled with the absence of perched conditions suggest that perched groundwater is discontinuous and merges or infiltrates into the deep aquifer east of the site. Low BTEX and TCE concentrations have been detected in well S13-MW17, which is an upgradient deep well.
- Based on fate-and-transport modeling, BTEX compounds in groundwater have reached a steady-state condition with concentrations above MCLs reaching a maximum distance of 270 feet. TCE is estimated to reach a maximum concentration of 7 µg/L in 20 years and will not migrate farther than approximately 300 feet from the site. The extent of downgradient migration is limited by hydrogeologic conditions (i.e., the extent of the perched water-bearing zone)

- The groundwater present under 12 Area, Site 13 would not be considered a potential source of drinking water based on the sustainable yield and TDS criteria in SWRCB Resolution 88-63.
- The RME risk to a hypothetical adult domestic groundwater user, based on default exposure assumptions and USEPA toxicity factors, was estimated to be $3 \times 10^{-3}$. The maximum route-specific adult hazard index was estimated to be 3 and the maximum child hazard index was 7. Domestic use of the groundwater is extremely unlikely.
- For a hypothetical on-site commercial/industrial indoor receptor, the estimated incremental RME risk from the vapor intrusion pathway (shallow groundwater to indoor air) is approximately $6 \times 10^{-7}$ using USEPA toxicity factors and the corresponding risk based on California toxicity factors was $2 \times 10^{-6}$. Based on the conservative nature of the evaluation, further evaluation of vapor intrusion into indoor air is not recommended.
- Based on the site-specific tiered ecological risk assessment for 12 Area, Site 13, the existing land-use designations, land-use plans, and a lack of complete exposure pathways to ecological receptors, the site does not need to be considered further in the ecological risk assessment process.

Technology screening was performed to identify potential remedial measures that would be effective in addressing the observed soil contamination. Based on this evaluation, the following alternatives were developed and evaluated in this FS:

Alternative 12A-1: No Action

Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal

This alternative relies on administrative control measures to ensure that the affected groundwater would not be extracted or used for any purpose in the future, thereby maintaining the current lack of exposure to, and risks from, groundwater contaminants. Groundwater monitoring would ensure that groundwater contamination is not migrating off site toward the Santa Margarita River basin. Product removal in the source area will reduce the contaminant source to the degree possible, thereby enhancing the ability of the aquifer to more quickly decrease contaminant concentrations over time.

This alternative would also utilize a passive product recovery in the source area (S13-MW1). Light nonaqueous phase liquid (LNAPL) recovery is required to remove the contaminant source to the degree possible, thereby enhancing the ability of the aquifer to decrease contaminant concentrations over time. Since the LNAPL layer appears to be confined to a single well, LNAPL recovery will only be implemented at well S13-MW1. Intermittent LNAPL recovery was previously performed at this well from 1996 to 2001, resulting in recovery of only approximately 10 gallons of product over 5 years (Appendix A5, RI Report). The passive product recovery would be implemented using a skimmer system.

Since 12 Area, Site 13 groundwater is not classified for beneficial use under federal or state standards, drinking water standards do not apply for this site. Rather, groundwater RGs for this site are designed to protect the beneficial-use waters of the Santa Margarita River basin downgradient of the site. The maximum concentration of a COC at the downgradient edge of the site resulting in concentrations below drinking water standards

at the entry point to the Santa Margarita River basin (i.e , Lake O'Neill), is defined as the groundwater RG.

Groundwater modeling results indicate that a sustained concentration of 50 µg/L of TCE in downgradient monitoring wells would result in corresponding concentrations at Lake O'Neill of 0.5 µg/L (i.e., background) and 5 µg/L (i.e., MCL), in approximately 41 and 50 years, respectively. Background is defined as 0.5 µg/L in accordance with California Code of Regulations (CCR) detection limits for purposes of reporting for VOCs. Similar modeling conducted for BTEX compounds indicates that sustained concentrations upwards of 500 µg/L in downgradient monitoring wells would breakdown to below detection limits long before they reach Lake O'Neill

If contaminants in site groundwater continue to exhibit no downgradient migration, there will be no significant impact on beneficial-use groundwater, including the drinking water resources in the Santa Margarita River basin Therefore, the RGs are designed to provide ample early warning of off-site migration at levels of concern to downgradient receptors. Actual BTEX and TCE concentrations in groundwater at 12 Area, Site 13 are well below their RGs.

The DON recognizes that the key substantive requirements of CCR Title 22, § 66264.94 (and the identical requirements of CCR Title 23, § 2550.4 and Section III.G of SWRCB Res. 92-49) require cleanup to background levels of constituents unless such restoration proves to be technologically or economically infeasible and an alternative cleanup level of constituents will not pose a substantial present or potential hazard to human health or the environment. At Site 13, considerable expense would be incurred to implement an active remediation system to achieve non-detectable concentrations (or MCLs) at the site in a short timeframe. Because site groundwater is not useable as a drinking water source, it is considered economically infeasible to incur considerable expense to achieve no measurable benefit in terms of reduction in risk to human health or the environment

Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2

In addition to the institutional controls, limited groundwater monitoring to ensure that there is no downgradient migration of contaminated groundwater, and passive product removal in the source area (Alternative 12A-2), this alternative involves implementing a long-term monitoring program to document the performance and effectiveness of natural attenuation to contain and degrade groundwater contaminants to prevent off-site migration that would reach downgradient receptors. The logistics associated with the implementation of this alternative would be addressed in a Remedial Action/Monitored Natural Attenuation Work Plan for the site. Because actual contaminant concentrations in groundwater are already below the recommended RGs, the success of this alternative relies on the ability of natural attenuation processes (e.g., dispersion, degradation, sorption, and volatilization) to effectively contain and prevent VOC migration.

The overall objectives of the performance monitoring for MNA at 12 Area, Site 13 include:

- Demonstrate that natural attenuation is occurring according to expectations.
- Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other) that may reduce the efficacy of natural attenuation processes.
- Identify any potentially toxic and/or mobile transformation by-products.

- Verify that the plume is not expanding.
- Verify there is no unacceptable impact to downgradient receptors.
- Demonstrate the efficacy of institutional controls to protect potential receptors.
- Verify attainment of remediation objectives.

Long-term monitoring would be required to document contaminant removal from the groundwater system, and to verify that MNA is proceeding to acceptable endpoints. The plan would comply with USEPA guidance for performance monitoring of MNA remedies for VOCs in groundwater (USEPA, 2004a)

Natural attenuation of petroleum hydrocarbons has been documented at 12 Area, Site 13 based on several years of data, and the existing monitoring network is adequate for implementation of this remedy.

The results of the comparative analysis for 12 Area, Site 13 are summarized below.

| Criteria | Alternative | | |
|---|---|---|---|
| | 12A-1[a] | 12A-2[b] | 12A-3[c] |
| **Threshold Criteria** | | | |
| Overall Protection of Human Health and the Environment | No | Yes | Yes |
| Compliance with ARARs | No | Yes | Yes |
| **Balancing Criteria** | | | |
| Long-Term Effectiveness and Permanence | Low | High | High |
| Reduction of Toxicity, Mobility, or Volume by Treatment | Low | High | High |
| Short-Term Effectiveness | Low | Moderate | Moderate |
| Implementability | Not Rated | High | High |
| Cost ($ million) | 0 | $0.32 | $0.44 |
| Remedial Timeframe | N/A | 20[d] | 20[d] |

[a] No Action
[b] Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal.
[c] Monitored Natural Attenuation with Alternative 12A-2.
[d] Assumed monitoring timeframe. RGs are currently met at the site, and the site conditions are anticipated to stay in compliance with RGs.

Alternative 12A-1 is not protective of human health; does not meet ARARs; provides little short- or long-term effectiveness and permanence; achieves no reduction in toxicity, mobility, or volume through active treatment; and has no associated cost.

Both Alternatives 12A-2 and 12A-3 would provide adequate protection of human health and the environment and comply with ARARs. Both alternatives provide short-term effectiveness and are readily implementable. The plume behavior over the last 10 years supports fate-and-transport predictions that detectable contaminant concentrations in groundwater are not migrating. For cost estimating purposes, 20 years of long-term monitoring was assumed. Alternatives 12A-2 and 12A-3 would provide a high degree of long-term effectiveness and permanence by reaching MCLs sooner; the highest reduction in toxicity, mobility, or volume through treatment; and a decreased remediation

time Alternative 12A-2 would provide the monitoring necessary to track plume movement and ensure effectiveness, as well as the necessary restrictions to limit exposure to the site contaminants. In addition, Alternative 12A-3 includes monitoring to evaluate the effectiveness of MNA. Alternative 12A-2 is the least costly alternative that would be protective of human health and the environment and achieve ARARs.

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Appendix B Selected Figures from the OU 5 RI (Parsons, 2004)
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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| µg/kg | microgram per kilogram |
| µg/L | microgram per liter |
| ABS | dermal absorption |
| ACL | alternative concentration limit |
| AFCEE | Air Force Center for Environmental Excellence |
| AM | action memorandum |
| amsl | above mean sea level |
| APCD | Air Pollution Control District |
| AQMD | Air Quality Management District |
| AR | Administrative Record |
| ARAR | applicable or relevant and appropriate requirement |
| ATTIC | Alternative Treatment Technology Information Center |
| BACT | best available control technology |
| BERA | baseline ecological risk assessment |
| bgs | below ground surface |
| BTEX | benzene, toluene, ethylbenzene, and total xylenes |
| °C | degree Celsius |
| CAA | Clean Air Act |
| CAH | chlorinated aliphatic hydrocarbon |
| Cal/EPA | California Environmental Protection Agency |
| Cal/OSHA | California Occupational Safety and Health Administration |
| Camp Pendleton | United States Marine Corps Base, Camp Pendleton |
| CAMU | Corrective Action Management Unit |
| CAO | cleanup and abatement order |
| CAP | Corrective Action Plan |
| CCR | California Code of Regulations |
| CDD | chlorinated dibenzodioxin |
| CDF | chlorinated dibenzofuran |
| CDFG | California Department of Fish and Game |
| CDM | Camp, Dresser, & McKee, Inc. |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| CLU-IN | Hazardous Waste Cleanup Information |
| CMECC | California Military Environmental Coordination Committee |
| CNDDB | California National Diversity Data Base |
| CNPS | California Native Plant Society |
| $CO_2$ | carbon dioxide |
| COC | chemical of concern |
| COPC | chemical of potential concern |
| cm/sec | centimeter per second |
| CSM | conceptual site model |
| CT | central tendency |
| CTR | California Toxics Rule |
| CWA | Clean Water Act |

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| DB | dichlorophenoxybutyric |
| DCA | dichloroethane |
| DCE | dichloroethene |
| DDD | dichlorodiphenyldichloroethane |
| DDE | dichlorodiphenyldichloroethene |
| DDT | dichlorodiphenyltrichloroethane |
| DLM | designated level methodology |
| DLR | detection limit for purposes of reporting |
| DNAPL | dense nonaqueous phase liquid |
| DO | dissolved oxygen |
| DoD | U.S. Department of Defense |
| DOI | U.S. Department of the Interior |
| DON | U.S. Department of the Navy |
| DOT | U.S. Department of Transportation |
| DPDO | Defense Property Disposal Office |
| DRMO | Defense Reutilization and Marketing Office |
| DTSC | Department of Toxic Substances Control (Cal/EPA) |
| | |
| EE/CA | engineering evaluation/cost analysis |
| EP | extraction procedure |
| EPI | Estimator Program Interface |
| EPC | exposure point concentration |
| ERA | ecological risk assessment |
| ESA | Endangered Species Act |
| ET | evapotranspiration |
| | |
| °F | degree Fahrenheit |
| FFA | Federal Facility Agreement |
| FR | Federal Register |
| FS | feasibility study |
| FSSG | Force Service Support Group |
| ft/day | feet per day |
| ft/ft | foot per feet |
| | |
| GIS | geographic information system |
| gpd | gallon per day |
| gpm | gallon per minute |
| GRA | general response action |
| GSA | Government Services Agreement |
| | |
| $H_2O_2$ | hydrogen peroxide |
| HEAST | health effects summary table |
| HHRA | human health risk assessment |
| HI | hazard index |
| HpCDD | heptachlorodibenzo-p-dioxin |
| HpCDF | heptachlorodibenzofuran |
| HQ | hazard quotient |
| HSP | health and safety plan |
| HSWA | Hazardous and Solid Waste Amendment |

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| HxCDD | hexachlorodibenzo-p-dioxin |
| HxCDF | hexachlorodibenzofuran |
| IA | Institutional Action |
| IR | Installation Restoration |
| IRIS | integrated risk information system |
| IRP | Installation Restoration Program |
| IT | International Technology Corporation |
| $KMnO_4$ | potassium permanganate |
| LDR | land disposal restrictions |
| LNAPL | light nonaqueous phase liquid |
| MALC | maximum allowable leachate concentrations |
| MCB | Marine Corps Base |
| MCL | maximum contaminant level |
| MCLG | maximum contaminant level goals |
| meqNa/100g | milliequivalents of sodium per 100 grams |
| mg/kg | milligram per kilogram |
| mg/L | milligram per liter |
| MNA | monitored natural attenuation |
| msl | mean sea level |
| NAAQS | National Ambient Air Quality Standards |
| NAC | natural attenuation capacity |
| NaOH | sodium hydroxide |
| NAPL | nonaqueous phase liquid |
| NAS | Natural Attenuation Software |
| NAWQC | National Ambient Water Quality Criteria |
| NCP | National Contingency Plan |
| ND | no detection |
| NEESA | Naval Energy and Environmental Support Activity |
| NEPA | National Environmental Policy Act |
| NFESC | Naval Facilities Engineering Services Center |
| ng/kg | nanogram per kilogram |
| NHPA | National Historic Preservation Act |
| NPL | National Priority List |
| NPWCSD | Navy Public Works Center, San Diego |
| $O_3$ | ozone |
| O&M | operation and maintenance |
| OCDD | octachlorodibenzo-p-dioxin |
| OCDF | octachlorodibenzofuran |
| OEHHA | Office of Environmental Health and Hazard Assessment |
| OHM | OHM Remediation Services Corporation |
| OPPT | Office of Pollution Prevention |
| ORD | Office of Research and Development |
| ORP | oxidation/reduction potential |

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| OU | Operable Unit |
| PAH | polynuclear/polycyclic aromatic hydrocarbon |
| PCB | polychlorinated biphenyl |
| PCDD | polychlorinated dibenzodioxin |
| PCDF | polychlorinated dibenzofuran |
| PCE | tetrachloroethene |
| PeCDD | pentachlorodibenzo-p-dioxin |
| PeCDF | pentachlorodibenzofuran |
| pg/g | picograms per gram |
| pH | negative $\log_{10}$ of hydrogen ion concentration |
| POTW | publicly owned treatment works |
| PPE | personal protective equipment |
| ppm | part per million |
| PRB | permeable reactive barrier |
| PRG | preliminary remediation goal |
| QAPP | quality assurance project plan |
| RAGS | Risk Assessment Guidance for Superfund |
| RAO | remedial action objective |
| RAP | remedial action plan |
| RCRA | Resource Conservation and Recovery Act |
| RFA | RCRA Facility Assessment |
| RfCs | air reference concentration |
| RfDi | inhalation reference dose |
| RG | remediation goal |
| RI | remedial investigation |
| RI/FS | remedial investigation/feasibility study |
| RME | reasonable maximum exposure |
| ROD | Record of Decision |
| RWQCB | Regional Water Quality Control Board |
| SAP | sampling and analysis plan |
| SARA | Superfund Amendments and Reauthorization Act |
| SCAQMD | Southern California Air Quality Management District |
| SCR | Syracuse Research Corp. |
| SDWA | Safe Drinking Water Act |
| SEV | screening ecotoxicity value |
| SFi | inhalation slope factor |
| SHPO | State Historic Preservation Officer |
| SIP | State Implementation Plan |
| SRA | screening risk assessment |
| S/S | solidification/stabilization |
| STLC | soluble threshold limit concentration |
| SVE | soil vapor extraction |
| SVOC | semivolatile organic compound |
| SWDA | Solid Waste Disposal Act |
| SWDIV | Southwest Division Naval Facilities Engineering Command |

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| SWRCB | California State Water Resources Control Board |
| TBC | to be considered |
| TCA | trichloroethane |
| TCB | trichlorobenzene |
| TCDD | tetrachlorodibenzo-*p*-dioxin |
| TCDF | tetrachlorodibenzofuran |
| TCE | trichloroethene |
| TCLP | toxicity characteristic leaching procedure |
| TCP | trichloropropane |
| TDS | total dissolved solids |
| TEF | toxicity equivalency factor |
| TEQ | toxicity equivalent |
| TMB | trimethylbenzene |
| TOC | total organic carbon |
| TOR | time of remediation |
| TOS | time-of stabilization |
| TRV | toxicity reference values |
| TTLC | total threshold limit concentration |
| TTU | transportable treatment unit |
| UCL | upper confidence limit |
| URF | unit risk factor |
| USC | United States Code |
| USEPA | United States Environmental Protection Agency |
| USFWS | United States Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| UST | underground storage tank |
| UTS | universal treatment standards |
| UV | ultraviolet |
| VISITT | Vendor Information System for Innovative Treatment Technologies |
| VOC | volatile organic compound |
| WET | wet extraction test |
| WMA | waste management area |
| WQCP | Water Quality Control Plan |
| WMU | waste management units |
| WQO | water quality objective |
| ZVI | zero-valent iron |

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# 1.0 INTRODUCTION

This Feasibility Study (FS) report provides a range of remedial alternatives for four Operable Unit (OU) 5 sites at the Marine Corps Base Camp Pendleton, California (MCB Camp Pendleton or the Base) (Figure 1-1). This document was prepared by Parsons for the Naval Facilities Engineering Command, Southwest Division (SWDIV) under Government Services Agreement (GSA) Contract Number GS-10F-0179J, Delivery Order Number N68711-00-F7907.

Delivery of this document is pursuant to the MCB Camp Pendleton Federal Facility Agreement (FFA) between the U.S. Environmental Protection Agency (USEPA), the California Environmental Protection Agency, Department of Toxic Substances Control (Cal/EPA DTSC), the San Diego Regional Water Quality Control Board (RWQCB), and the Department of the Navy (DON). The FFA establishes a framework for implementing appropriate environmental response actions at the Base.

Per the agreements reached at the 29 August and 12 September 2000 FFA Project Management meetings, OU 5 was created to accommodate sites that require additional data collection and possible reevaluation of baseline risk. Based on the results of the OU 5 RI (Parsons, 2004), three OU 5 sites are included in this FS: Sites 1A-1, 1111, and 12 Area (Site 13). Contamination at these sites was determined to pose a risk to human health or the environment, and therefore require further action. Site 6A is part of OU 5 but was not evaluated in this FS because it was recommended for No Further Action based on the results of the remedial investigation (Parsons, 2004a). Site 21 was included in the Draft FS (Parsons, 2005a), but it was decided during the 24 May 2005 FFA Meeting that additional data were required prior to completing the FS; therefore it is not included in this Draft Final FS. Two OU 5 sites, Site 33 and 13 Area Force Service Support Group (FSSG) Lot, are not included in this FS Report because it was agreed by the FFA Team that additional field data needs to be collected at those sites prior to completing a feasibility study. These sites will be addressed in a separate RI and FS. Also, 22/23 Area Groundwater, although part of OU 5, is being addressed separately to allow for additional data collection to define the presence of 1,2,3-trichloropropane (TCP) above the state action level.

This FS provides summaries of the conditions, environmental setting, and results and recommendations from previous investigations for each OU 5 site. However, this document does not duplicate all of the information provided in the previous Remedial Investigation/Feasibility Study (RI/FS) documents. Detailed site descriptions, histories, regional and site-specific environmental information, and results of previous investigations and risk assessments are incorporated by reference. Previous studies and reports concerning each site are referenced in each site-specific section of this document.

## 1.1 Purpose and Objectives of the Feasibility Study

The purpose of this FS is to develop and evaluate remedial action alternatives for each of the OU 5 sites that comply with applicable or relevant and appropriate requirements (ARARs), are protective of human health and the environment, and can be implemented in a cost-effective manner. Sites 21 and 1111 were the subjects of a previous FS in which remedial alternatives were developed and evaluated (Parsons, 1999a). Remedial alternatives developed for each site are presented in detail in each site-specific section.

The main objectives of the FS report are as follows:

- Define the remedial action objectives (RAOs) for each site, and determine the remedial goals needed to meet them.
- Evaluate remedial technologies and process options and complete a technology screening matrix for each site.
- Develop final remedial alternatives for each site.
- Revise and update the ARARs analysis for Sites 21 and 1111 and complete the ARARs analysis for Site 1A-1 and 12 Area, Site 13.

## 1.2 Report Organization

This report follows the suggested approaches and structure provided in applicable guidance documents including USEPA *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988) and the Department of the Navy Installation Restoration Manual (U. S. Navy, 2001c). Section 1 provides a general introduction to the report including information on OU site designations, purpose and objectives of the FS, and an overview of the nine National Contingency Plan (NCP) Evaluation Criteria. Sections 2 through 5 provide site-specific information for four OU 5 sites, including site history, local environmental settings, and site summaries of previous investigations. These sections also document the results of the FS for each site, including site-specific ARARs evaluation, development of remedial action objectives (RAOs), screening of technologies and process options, and development and detailed analysis of remedial alternatives. Section 6 lists the references cited throughout the report.

Appendices to this document contain supporting information including ARARs evaluation (Appendix A), selected figures from the OU 5 RI (Appendix B), vadose and groundwater fate-and-transport modeling (Appendix C), human health risk calculations (Appendix D), ecological risk calculations (Appendix E), and remedial alternative cost estimates (Appendix F).

## 1.3 MCB Camp Pendleton Location and Description

MCB Camp Pendleton is located in northern San Diego County, California (Figure 1-1), approximately halfway between the cities of Los Angeles and San Diego. Surrounding communities include San Clemente to the northwest, Oceanside to the south, and Fallbrook to the east. The Base is bordered on the west by the Pacific Ocean and encompasses 17 miles of relatively undisturbed coastline. Rolling hills and valleys range inland an average of 10 to 12 miles. The Base occupies approximately 125,000 acres of land and is the Marine Corps' primary amphibious training center.

Base areas and the locations of the OU 5 sites are shown on Figure 1-1. Sites 1A-1, 6A, 21, 1111, and 12 Area, Site 13 are located in the southeastern portion of the Base.

Construction of MCB Camp Pendleton began in March 1942, and President Franklin D. Roosevelt dedicated the Base in September 1942. It was designated as a permanent Base in October 1944. Nearly 60,000 personnel train at Camp Pendleton every year, with over 35,000 service members actually assigned to the Base (MCB Camp Pendleton, 2001).

Land use within the perimeter of the Base consists of airfield operations, maneuver and impact areas, troop and family housing, recreation areas, and out-leased areas used by various entities (e.g , San Onofre Nuclear Generating Station and agriculture). Most of the land within MCB Camp Pendleton is open and undeveloped and directly supports the training mission of the Base. Developed areas of the Base are isolated from one another by large areas of essentially undeveloped land used for training and maneuvers. The largest concentration of development is at the Headquarters Area in the southeast corner of the Base. The second largest concentration is the housing areas in the southwest corner of the Base, near the Oceanside Gate (Innis-Tennebaum Architects, Inc., 1990).

Additional information on land use in specific areas of the Base and expected future land use at MCB Camp Pendleton and in surrounding communities is presented in the MCB Camp Pendleton Master Plan (Innis-Tennebaum Architects, Inc., 1990).

## 1.4 Applicable or Relevant and Appropriate Requirements and Guidance to be Considered

In performing this FS and subsequent remedial actions (if needed) for Sites 1A-1, 21, 1111, and 12 Area, Site 13, the DON is required to comply with ARARs within the framework of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Superfund Amendments and Reauthorization Act (SARA), and the National Contingency Plan (NCP).

Applicable requirements are federal and state statutory and regulatory requirements that directly and fully address or regulate the hazardous substance, pollutant, contaminant, action being taken, or other circumstance at a CERCLA site. Relevant and appropriate requirements are federal and state human health and environmental statutory and regulatory requirements that address problems or situations similar to those encountered at CERCLA sites. They are appropriate to the circumstances of release or threatened release such that their use is well suited to the particular site. Relevant and appropriate requirements are intended to carry the same weight as applicable requirements.

In addition, advisories, criteria, or guidance developed by the USEPA and other federal, state, or local agencies are designated as "to be considered" (TBC). TBCs generally fall into three categories: health effects information with a high degree of credibility (e.g., risk doses), technical information on how to perform or evaluate site investigations or response actions, and policy. TBCs are considered when ARARs do not exist or are not sufficient to protect human health and the environment at a CERCLA site. Because they are not promulgated and are not legally binding, they do not carry the same weight as ARARs. However, in some circumstances, TBCs may be considered along with ARARs when determining the necessary level of cleanup to protect human health or the environment. The potential ARARs/TBCs identified for each of the OU 5 FS sites are evaluated in detail in Appendix A.

## 1.5 Development of Remediation Goals

This report presents RAOs for each OU 5 FS site designed to protect human health and the environment. The section outlining RAOs specifies the remedial chemicals of concern (COCs), exposure routes and receptors, and acceptable contaminant concentrations or range of concentrations for each exposure route. The RAOs provide the basis for developing remediation goals for each contaminant and medium and remedial action alternatives designed to meet those goals.

This section describes the general approach used in establishing remediation goals for soil and groundwater media at the OU 5 FS sites. Site-specific remediation goals are presented in Sections 2 through 5 of this report.

### 1.5.1 Soil

Remedial goals (RGs) were developed to meet the RAOs for each site. Preliminary RGs were developed for the compounds that, under baseline conditions, pose a hypothetical significant risk to human or ecological receptors as outlined in the Draft Final RI Report (Parsons, 2004)

In accordance with the US Navy (1999e) guidance, the exposure and effects information used in the Tier-2 BERAs were used to develop a range of concentrations for ecological preliminary RGs. The values selected, as a site- and chemical-specific ecological preliminary RG, is the lowest of the ecological preliminary RGs for any wildlife receptor, derived using an effect-based toxicity reference values (TRVs).

Human health risk-based preliminary RGs were derived using the risk predictions presented in Appendix I of the OU 5 RI Report (Parsons, 2004). Preliminary RGs were calculated using both California modified toxicity data and USEPA recommended toxicity data. The hierarchy of sources for the toxicity data used for each of these scenarios, risk and hazard calculation methodology, and exposure parameters and assumptions are described in detail in Appendix I of the OU 5 RI Report (Parsons, 2004) and are not repeated in this document.

Preliminary RGs were only calculated for 1) receptors whose cumulative risk or hazard predictions were above target cancer risk ($1 \times 10^{-6}$) or noncancer hazard (1) levels for the reasonable maximum exposure (RME) scenario, and 2) site-related analytes that were determined to be COCs (i.e., those analytes with predicted risks above $1 \times 10^{-6}$ and contributing significantly to predicted receptor cumulative risks).

For determining appropriate RGs for compounds that may pose a threat to underlying groundwater, a fate-and-transport analysis was conducted to determine the residual levels of COCs that can remain in site soils and still be protective of groundwater.

For each COC, the preliminary RG with the lowest concentration was selected from among the combined receptor preliminary RGs as the final RG. For each site these values are tabulated, indicating the preliminary and final RGs for each COC.

In the event that soils are excavated from a particular OU 5 site, confirmation sampling will be necessary as described in detail in each site-specific section.

### 1.5.2 Groundwater

Groundwater RGs were established for each groundwater site to satisfy the substantive provisions of the chemical-specific ARARs discussed in Appendix A.

Drinking water standards and background were used in the development of RGs for Site 1111, which is classified as a potential source of drinking water according to federal and state criteria. The more stringent of the federal and state maximum contaminant levels (MCLs), and, where those were unavailable, nonzero maximum contaminant level goals (MCLGs), were determined as the groundwater RG for each contaminant. Ecological considerations were not used to develop groundwater RGs because the exposure of potential ecological receptors to volatile organic compounds (VOCs) in shallow groundwater at the OU 5 sites would be at concentrations of only minor concern. Although background levels of VOCs are essentially zero, a concentration of zero cannot

be measured. Therefore, a value of 0.5 microgram per liter (µg/L) is considered the background (or detectable) level of VOCs for purposes of evaluating groundwater remedial alternatives. (i.e., the residual risk associated with cleanup to background would be based on a residual contaminant level of 0.5 µg/L rather than assuming a concentration of zero). This background value must be consistent with detection limits for purposes of reporting (DLRs) for VOCs promulgated under California Code of Regulations (CCR) Title 22, Division 4, Chapter 15, Article 5.5, and therefore may be lower than 0.5 µg/L for specific analytes

In addition to drinking water standards and background, carcinogenic and noncarcinogenic preliminary tap water preliminary remedial goals (PRGs) established by the USEPA Region 9 were used as TBC criteria for Site 1111. These are useful in helping to determine what is protective at the site when a drinking water standard is not established.

Calculated concentrations based on groundwater modeling were used in the development of RGs for Sites 21 and 12 Area, Site 13, which are not classified as potential drinking water sources according to federal and state criteria Groundwater RGs at these sites were defined as the maximum concentration allowed in groundwater monitoring wells at the downgradient edge of each site that would be protective of drinking water resources in the Santa Margarita River basin. For modeling purposes, Lake O'Neill was determined as the entry point to the Santa Margarita River basin for any contaminant migration from these sites. Lake O'Neill is located approximately 4,000 feet and 5,900 feet downgradient of Sites 21 and 12 Area, Site 13, respectively. The calculated RGs are designed to provide ample early warning of off-site migration at levels of concern to downgradient receptors.

This FS report provides an analysis of the range of remedial alternatives available to clean up groundwater to both background and drinking water standards at Site 1111, and to calculate RGs for Sites 21 and 12 Area, Site 13. It provides the information needed by decision-makers to select the best technically and economically feasible alternative to achieve the remedial action objectives Consistent with this approach, this FS focuses on cost-benefit issues such as risk reduction and impacts to beneficial use. However, it does not include an analysis aimed at selecting the final remedy. These decisions will be made during the Proposed Plan and Record of Decision (ROD) stages.

## 1.6 Overview of Detailed Analysis and Nine NCP Evaluation Criteria

CERCLA remedial actions must satisfy the following statutory analysis requirements, as addressed in the ROD and supported by the FS:

- Protect human health and the environment
- Attain ARARs (or provide grounds for invoking a waiver)
- Be cost-effective
- Use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable
- Satisfy the preference for treatment that reduces contaminant toxicity, mobility, or volume as a principal element or explain why it does not.

CERCLA requirements emphasize evaluating the following long-term effectiveness and related considerations for remedial action alternatives:

- Long-term uncertainties associated with land disposal
- Goals, objectives, and requirements of the Solid Waste Disposal Act (SWDA)
- Persistence, toxicity, and mobility of hazardous substances and their constituents and propensity to bioaccumulate
- Short- and long-term potential for adverse health effects from human exposure
- Long-term maintenance costs
- Potential for future additional remedial action costs if the remedial action alternative were to fail
- Potential threat to human health and the environment associated with excavation, transportation, and disposal or containment.

Nine evaluation criteria were developed under the NCP to select a site remedy from remedial action alternatives to address the CERCLA requirements and considerations listed above, as well as additional technical and policy considerations. The nine criteria are divided into two threshold criteria, five balancing criteria, and two modifying criteria, as summarized below. The NCP requires that a detailed evaluation of each alternative address each of the nine criteria. The nine NCP criteria are listed below and briefly described in the following paragraphs.

**NINE NCP EVALUATION CRITERIA FOR DETAILED ANALYSIS OF ALTERNATIVES**

| | |
|---|---|
| **Threshold Criteria** | • Overall protection of human health and the environment<br>• Compliance with ARARs |
| **Balancing Criteria** | • Long-term effectiveness and permanence<br>• Reduction of toxicity, mobility, or volume through treatment<br>• Short-term effectiveness<br>• Implementability<br>• Cost |
| **Modifying Criteria** | • State acceptance<br>• Community acceptance |

### 1.6.1 Overall Protection of Human Health and the Environment

The analysis evaluates how the remedial action alternative reduces the risk to human health and the environment from potential exposure pathways using treatment, engineering, or institutional controls. This evaluation also examines whether alternatives pose any unacceptable cross-media impacts.

### 1.6.2 Compliance with ARARs

This analysis evaluates the ability of each alternative to attain the promulgated federal and state chemical-, action-, and location-specific ARARs. If an ARAR cannot be met, the analysis of the alternative must provide the grounds for a statutory waiver.

### 1.6.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence are evaluated with respect to the magnitude of residual risk and the adequacy and reliability of controls used to manage the remaining waste (untreated waste and treatment residuals) over the long term. Alternatives that offer the highest degree of long-term effectiveness are those that leave little or no waste on site, thus eliminating long-term maintenance and monitoring and minimizing reliance on institutional controls.

### 1.6.4 Reduction of Toxicity, Mobility, and Volume through Treatment

This evaluation relates to the CERCLA guidance in preferring a remedial action that reduces the toxicity, mobility, or volume of hazardous substances. The analysis addresses the expected performance of treatment technologies used by considering the amount of waste treated or destroyed, the irreversibility of the treatment process, and the type and quantity of residuals resulting from the treatment process.

### 1.6.5 Short-Term Effectiveness

Short-term effectiveness addresses the effectiveness of an alternative to protect human health and the environment during construction and implementation of a remedy. It considers:

- Protection of the surrounding community during remedial actions
- Protection of workers during remedial actions
- Environmental impacts from implementing the action
- Time required to achieve cleanup goals.

### 1.6.6 Implementability

This evaluation examines the technical and administrative feasibility of implementing an alternative and the availability of necessary goods and services. Technical factors to be assessed include:

- Ease and reliability of initiating construction and operations
- Reliability of the technology
- Ease of undertaking additional remedial actions, if necessary
- Ability to monitor effectiveness of the remedy
- Ability to obtain approvals from other agencies
- Coordination with other agencies
- Availability of off-site treatment, storage and disposal services capacity
- Availability of necessary equipment and specialists
- Availability of prospective technologies.

Where proven technologies are proposed, an assessment of technical feasibility examines the performance history of the technologies in direct applications, or considers the expected performance for similar applications. For innovative technologies, protocols for prospective or on-going treatability studies to demonstrate performance are presented.

### 1.6.7 Cost

The cost estimates presented in this report are rough order-of-magnitude estimates ranging from plus 50 to minus 30 percent of the actual cost. This is the level-of-accuracy dictated by USEPA guidance for developing the cost estimate. Estimates are based on a variety of information, including quotes from local suppliers, generic unit costs, vendor information, conventional cost estimating guides, and previous experience. The costs were prepared using available information to provide guidance in project evaluation and implementation. Uncertainties in estimating volumes of contaminated soil could affect the estimated costs.

Capital costs include those expenditures required to implement a remedial action. Both direct and indirect costs are considered in developing capital cost estimates. Direct costs include construction costs or expenditures for equipment, labor, and materials required to implement a remedial action. Indirect costs include engineering, permitting (as required), construction management, and other services necessary to carry out a remedial action.

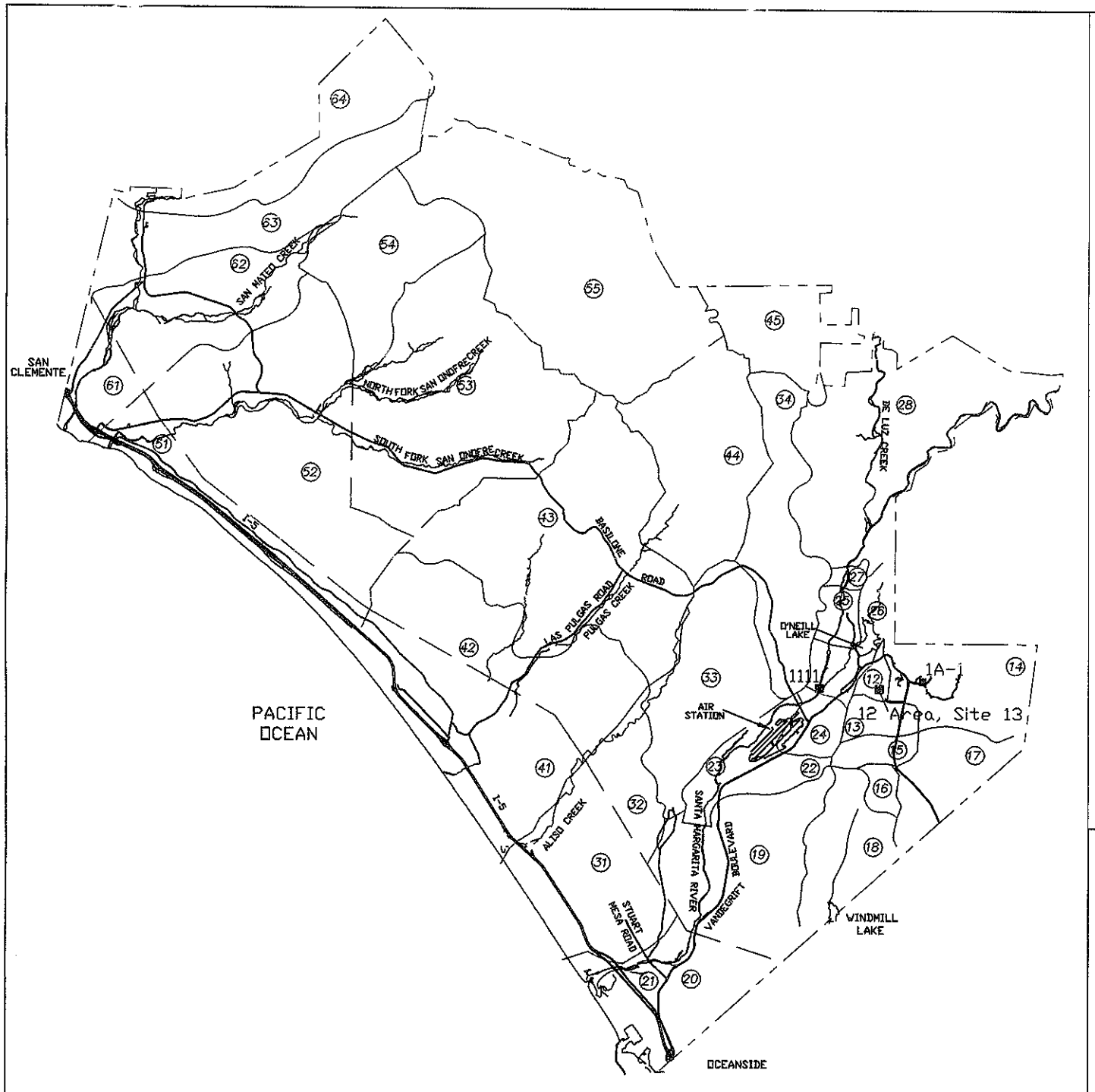
Annual operation and maintenance (O&M) costs, which include labor, maintenance materials, energy, and purchased services, also were estimated. The estimates also include those O&M costs that may be incurred even after the initial remedial activity is complete (e.g. long-term monitoring).

### 1.6.8 State Acceptance

The state's preferences or concerns about the alternatives will be reflected in the OU 5 Proposed Plan for these sites

### 1.6.9 Community Acceptance

The community's preferences or concerns about the alternatives will be evaluated during the Proposed Plan stage and will be reflected in the OU 5 Record of Decision (ROD) for these sites




LEGEND

- Major Area Boundaries
- Roads And Highways
- Creeks and Streams
- MCB Camp Pendleton Boundary
- (53) Major Area Designation
- 1A-1 ■ OU 5 FS Site Location

N

0 15,000 30,000

SCALE IN FEET

SOURCE: IT, INC.

**Figure 1-1**

**Locations of Base Areas and OU 5 FS Sites**

MCB Camp Pendleton, California

**PARSONS**

Pasadena, CA

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## 2.0 SITE 1A-1

Site 1A-1 is a debris disposal area approximately 1.5 acres and 750 feet north-northeast of Installation Restoration (IR) Site 1A in the 14 Area. Site 1A is immediately northeast of Base Sewage Treatment Plant No. 1 (Figure 2-1). Pilgrim Creek Trail runs along the eastern boundary of the site (Figure 2-2). Pilgrim Creek is located east and south of the site.

### 2.1 Background Information

Although this FS provides a summary of site conditions, it does not repeat all the information provided in previous documentation regarding the detailed site description, site history, regional and site-specific environmental information, or results of previous investigations and risk assessments. This information is incorporated by reference as appropriate and is documented in the following report:

- Draft Final Operable Unit 5 Remedial Investigation Report for Sites 1A-1, 6A, 21, 1111, and 12 Area (Parsons, 2004).

#### 2.1.1 Site Description and History

Site 1A-1 has visible surface debris. Because this visible surface debris indicated the possible presence of a larger volume of buried debris, Site 1A-1 was determined to be an IR site requiring characterization data, and was placed in OU 5 in 2001 to determine if any site chemicals of potential concern (COPCs) pose a significant risk to human health or the environment. Based on data obtained from two phases of field investigation (Parsons, 2004), Site 1A-1 was confirmed as a former waste disposal area, possibly associated with another nearby disposal area, Site 1A. These investigations have found Site 1A-1 to contain waste material and ash up to 10 feet thick.

Prior to 2001, no investigations had been performed at Site 1A-1, although characterization and remediation at Site 1A was conducted as part of OU 3 (SWDIV, 1996). Until 1970, refuse waste at the Base was disposed of by burning. Site 1A, located in close proximity to Site 1A-1 (Figure 2-1), was one of nine refuse burning areas used from 1942 through the early 1970s to burn refuse generated by Base operations. The entire Base generated an estimated annual waste quantity of 20,000 to 28,000 tons distributed over the nine burning grounds. The refuse burning areas were closed sometime between the late 1960s and 1971. Based on the historical aerial photographs at Site 1A-1, there does not appear to be organized disposal operations in the Site 1A-1 area at the time that each photograph was taken (Parsons, 2004). Waste was likely deposited before 1970, since the 1970 photograph indicates less site activity and more vegetation overgrowth. It does not appear that the waste materials were systematically covered with fill material given that visible debris can be currently observed at the surface across portions of Site 1A-1.

Site 1A-1 is no longer in operation, and military and civilian personnel cross the site infrequently because the vegetation is relatively dense. The land surrounding Site 1A-1 generally is covered with natural vegetation, except for Pilgrim Creek Trail along the eastern edge. The surrounding areas are undeveloped and classified as maneuver areas (IT, 1999). The nearest troop housing is approximately 0.25 mile southwest. The nearest family housing, De Luz Housing, is approximately 1.5 miles north. Sewage Treatment Plant No. 1 is located approximately 2,500 feet southwest.

The likelihood of future residential land use is considered low, given current development plans and current land use in the vicinity of the site. The nearest groundwater production wells to Site 1A-1 are over four miles from the site in the San Luis Rey River Basin. According to information received from the City of Oceanside, there are two production wells in the San Luis Rey River Valley near the intersection of North River Road and College Boulevard. These wells are designated as Well #4 and Well #5 (City of Oceanside, 2004). Future use of groundwater is considered improbable, given the limited saturated thickness of alluvium near the site.

### 2.1.2 Site Conditions

This section includes a brief description of site topography, surface water, geology, hydrogeology, and ecology, which are described in the OU 5 RI (Parsons, 2004)

#### 2.1.2.1 Topography

Site 1A-1 is located in a vegetated, undeveloped region. The site is at an elevation of approximately 285 to 350 feet above mean sea level (amsl) and is located in a valley between surrounding hills. The site contains berms and uneven topography apparently resulting from past rough grading operations. The site generally slopes slightly east toward Pilgrim Creek. The site is unpaved with no nearby surface structures, other than an unpaved road passing through the site in an east-west direction.

#### 2.1.2.2 Surface Water

Although Site 1A-1 is directly adjacent to Pilgrim Creek, a streambed with intermittent flow, no perennial surface water is present. The area receives low annual rainfall, primarily during the winter months. Surface water runoff during significant rainfall follows site surface topography and flows generally east into the Pilgrim Creek streambed. No water was present in Pilgrim Creek during field sampling in December 2001 or January 2003.

#### 2.1.2.3 Geology

Site 1A-1 is within a north-south trending valley referred to herein as Pilgrim Creek Valley. This generally V-shaped valley consists of consolidated igneous bedrock partly filled with unconsolidated alluvium (streambed sediments). The bedrock is essentially impermeable based on field observations. Figure 2-2 provides a map of observed surface geology. As shown on the map, the four primary geologic units in the site vicinity are bedrock, alluvium, artificial fill soils for the road, and waste fill soils.

Bedrock in the site vicinity consists of pre-Tertiary basement complex composed of igneous and metamorphic rocks, primarily tonolite and granodiorite (Walawender, 1991). The hard, impermeable nature of the bedrock is further confirmed by observations during drilling. As such, the streambed sediments (alluvium) that have accumulated on top of the bedrock, along the valley floor, contain the only groundwater present in the site vicinity. Alluvium is of Quaternary age, consisting primarily of the unconsolidated streambed sediments in Pilgrim Creek, although a thin layer of alluvium is present at some locations on the bedrock slopes These sediments are primarily sand and silty sand, and are up to 22 feet thick based on field logging

2.1.2.4 Hydrogeology

Groundwater is present in the Pilgrim Creek streambed sediments (unconsolidated Quaternary alluvium). Depth of groundwater below ground surface (bgs) within the streambed was approximately 12.5 feet at the time of drilling and installing monitoring well 1A1MW-1, although the water table in the Pilgrim Creek Valley is known to fluctuate based on historical data from monitoring wells at the nearby Site 1A (NPWCSD, 2003). Groundwater is not present in the bedrock underlying most of the waste fill soils (Parsons, 2004). Groundwater flow direction in the Pilgrim Creek streambed sediments is toward the southwest, which is the same as the flow of intermittent surface water. The hydraulic gradient of groundwater flow is 0.006 ft/ft based on the elevation of groundwater encountered in borings 1A1B-14, 1A1B-15, 1A1B-16, and 1A1MW-1 during the January 2003 field investigation. The gradient is consistent with the gradient calculated in the vicinity of Site 1A, approximately 750 feet south of Site 1A-1. The site is located within the Mission Hydrologic Subarea (3.11) of the San Luis Rey Hydrologic Unit (3.00) (RWQCB, 1994).

2.1.2.5 Ecology

A biological assessment was conducted adjacent to Site 1A to provide information regarding the effects to federal- and state-listed species that could potentially occur during remediation activities (IT, 1999). Dominant habitats in this area include a mixed sagebrush series (Sawyer and Keeler-Wolfe, 1995) and disturbed habitat. The common plant species of the mixed sagebrush series include sage (white and black), coyote brush, and buckwheat. A few willows and sycamore tress are scattered throughout the site area. Disturbed habitat consists primarily of ground sparsely vegetated with mustard or non-native grasses (IT, 1999).

Site 1A-1 is located within the known foraging area of nesting coastal California gnatcatchers. Biological resource monitoring may be required during any potential site remediation and/or further investigation activities if conducted during the breeding season

### 2.1.3 Nature and Extent of Contamination

Based on visual field evidence, Site 1A-1 soil contaminants likely originated from the disposal of waste materials onto an accessible open area near Site 1A. The site currently contains small hills and berms apparently resulting from past rough grading operations. Debris, ash, and discolored soils were observed in the soil borings. The waste material generally overlies a layer of silty sand overlying granitic bedrock. The debris layer contains extensive glass, metal fragments, and sand. Ash material was observed near the surface in borings 1A1B-02, 1A1B-07, and 1A1B-10 No prevalent odors were encountered during field sampling. Naturally occurring iron oxide staining was observed in some of the boring locations. Figures 2-7 to 2-9 in Appendix B1 summarize detectable contaminant concentrations in site soil samples.

2.1.3.1 Soil

Based on the historical photographs, visual inspections, field mapping, and soil sampling conducted at Site 1A-1, the volume of impacted soil above background and/or industrial soil PRGs is approximately 20,000 cubic yards This volume was calculated by multiplying the approximate area of contamination of 1.5 acres times the average depth of contamination estimated at about 8 feet, and represents a rough order-of-magnitude estimate. Based on the uncertainty of specific dimensions of depth and extent, this

estimate is considered to be within 20 percent of the actual volume. Field observations do not indicate the presence of debris in the Pilgrim Creek streambed, although trace concentrations of COPCs in the sediment samples indicate erosion of waste materials may have had a minor impact to streambed sediments directly adjacent to waste material.

#### 2.1.3.2 Groundwater

As described in the OU 5 RI (Parsons, 2004), groundwater is not present directly beneath the majority of waste soils. The nearest groundwater is in the Pilgrim Creek streambed, which underlies a small portion of the site. The downgradient groundwater monitoring well, 1A1MW-1, was installed in the Pilgrim Creek streambed and sampled in January 2003. No VOCs, semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), chlorinated herbicides, 1,4-dioxane, or dioxins/furans were detected in the groundwater sample. Metals concentrations in groundwater appear to be within naturally occurring ranges. None of the metals detected in groundwater exceeded MCLs or preliminary remediation goals (PRGs). Detected metals included barium, calcium, magnesium, manganese, mercury, molybdenum, potassium, sodium, vanadium, and zinc.

Geochemical parameters collected in the field included pH, temperature, conductivity, turbidity, dissolved oxygen (DO), and oxidation/reduction potential (ORP). The groundwater sample was analyzed for methane, ethane, chloride, nitrate, sulfate, alkalinity, total dissolved solids (TDS), and total organic carbon (TOC). Laboratory reported concentrations of chloride (336 milligrams per liter [mg/L]), sulfate (297 mg/L) and TDS (1,390 mg/L) were all detected above their respective MCLs. The groundwater geochemistry data are similar to that of Site 1A, approximately 750 feet south of Site 1A-1 (NPWCSD, 2003). In summary, there is no evidence of site-related contaminants in the downgradient monitoring well.

### 2.1.4 Contaminant Fate and Transport

Contaminant fate and transport is discussed in detail in the OU 5 RI (Parsons, 2004). This section provides a brief summary of the conditions specific to Site 1A-1 and the results of the supplemental evaluation included in Appendix C to establish soil RGs that are protective of groundwater.

There is no groundwater directly underlying the majority of the waste at the site. Because the majority of the waste does not directly overlie groundwater, the potential contaminant migration pathway would be along the bedrock surface, to the groundwater in the stream channel. The COPCs detected in soil at Site 1A-1 include VOCs, SVOCs, organochlorine pesticides, dioxins/furans, and metals. Of these chemicals, VOCs are the most mobile and likely to migrate farther from the source. Benzene is the most mobile VOC from a groundwater-impact perspective. However, there were no detectable concentrations of any contaminants in the downgradient well when it was sampled in January 2003.

VLEAH modeling during the OU 5 RI indicated that benzene was the only COC that could leach from waste soils at concentrations greater than its MCL of 1 µg/L. Supplemental VLEACH/SUMMERS evaluations, conducted in this FS to determine soil RGs for all five organic contaminants that failed the DLM in the RI, are presented in Appendix C. The modeling results, presented in Table C-7, indicate that none of the reported contaminant concentrations exceeded its maximum allowed leachate

concentration. Therefore, Site 1A-1 COCs do not pose a threat to groundwater under the current conditions based on data to date.

### 2.1.5 Human Health Risk Assessment

This section provides a brief summary of the Human Health Risk Assessment (HHRA) discussed in detail in the OU 5 RI (Parsons, 2004). As discussed previously, residential land use is considered highly unlikely at Site 1A-1. Therefore, the HHRA focused on hypothetical nonintrusive and intrusive workers and a military trainee receptor. The cumulative RME risk to a hypothetical nonintrusive worker was estimated to be $2 \times 10^{-4}$, with over 95 percent of the risk attributable to dioxins/furans. The corresponding central tendency [CT] risk estimate is $2 \times 10^{-6}$. The RME risk to an intrusive worker was $2 \times 10^{-6}$ with a CT estimate of $2.7 \times 10^{-7}$. The RME risk to a military training receptor was $4 \times 10^{-6}$ with a CT estimate of $3.1 \times 10^{-7}$. Cumulative hazard index (HI) estimates for all receptors were well below USEPA's target HI of one.

Although the predicted RME risk to a hypothetical nonintrusive worker is at the upper end of the USEPA risk management range (USEPA, 1991b), the site is considered to be protective of human health given (1) the overly conservative nature of the evaluation (i.e., CT risk estimates are considerably lower); (2) the hypothetical nature of any future on-site workers (i.e., there is a low likelihood of site development due to the ecologically sensitive nature of this area); and (3) the conservative use of maximum detected dioxin/furan concentrations in the risk estimates instead of a mean exposure point concentration. An institutional control limiting site development may be necessary.

Lead concentrations in soil at Site 1A-1 ranged up to 9,670 mg/kg. Default industrial-soil PRGs for lead were based on the USEPA (1996d) Adult Lead model, which utilizes an approach that relates soil lead intake to blood lead concentrations in the fetus of a woman of child-bearing age, who is the receptor assumed to be the most sensitive. The USEPA Adult Lead Model (1996b) default industrial soil PRG range was updated based on USEPA's re-analysis (2002c) and reported in the finalized Adult Lead Model technical guidance (USEPA, 2003). The lower end (780 mg/kg) of this updated range is consistent with USEPA Region 9's industrial soil PRG of 800 mg/kg (2004b). The 95 percent UCL mixed (0 to 10 feet bgs) and surface (0 to 1.5 feet bgs) soil exposure point concentration of 1,200 mg/kg is within the default PRG range of 780 to 1,200 mg/kg.

### 2.1.6 Ecological Risk Assessment

This section provides a brief summary of the Ecological Risk Assessment (ERA) discussed in detail in the OU 5 RI (Parsons, 2004). Concentrations of COPCs in soil were utilized to estimate exposures to a variety of potential ecological receptors: plants, terrestrial invertebrates, mammals, and birds. In Tier 1, estimated exposures were evaluated against screening ecotoxicity values (SEVs), defined as protective (conservative) concentrations of chemicals that are not associated with adverse ecological effects, while in Tier 2, further refinements were made to the exposure estimates and additional ecotoxicity concentrations were utilized, based on adverse-effect-inducing concentrations.

Because the SEVs were exceeded in Tier 1, the site does not qualify for a no further action decision, and the following COPCs were carried through to the Tier-2 Baseline Ecological Risk Assessment (BERA): 15 inorganics, one polynuclear/polycyclic aromatic hydrocarbon (PAH), two PCBs, nine pesticides, dioxins, three SVOCs, and 10 VOCs. Based on the refined analysis conducted in the Tier-2 assessment, three inorganic

COPCs (antimony, lead, and zinc) and dioxins are present at concentrations that are predicted to pose a potentially significant hazard to one or more ecological receptors.

In accordance with guidance-directed conclusion options from a Tier-2 BERA, these COPCs require additional consideration for remedy development in a Tier-3 assessment.

### 2.1.7 Summary of RI Conclusions

Based on the data collected to date and the analyses documented in this report, the following conclusions were reached in the OU 5 RI (Parsons, 2004) regarding Site 1A-1:

- The volume of impacted soils is approximately 20,000 cubic yards, with a thickness of up to 10 feet, and the spatial extent is approximately 1.5 acres. Field mapping, subsurface data collected during drilling, and analytical data were used to define the lateral and vertical extent of contamination. Analytical testing and field observations do not indicate the presence of debris in the Pilgrim Creek streambed.
- Some metals (primarily lead, iron, and arsenic), dioxins/furans, and organochlorine pesticides (4,4-dichlorodiphenyldichloroethane [DDD], 4,4-dichlorodiphenyldichloroethene [DDE], and 4,4-dichlorodiphenyltrichloroethane [DDT]) are present in the waste soils above their industrial-soil PRGs. These COPCs are relatively immobile and not likely to migrate downward far from the waste fill area.
- The highest concentrations of DDT/DDD/DDE are present in the southern portion of the site. The lateral and vertical extent of the elevated pesticide levels appears to be limited.
- Although no visible debris is present in the streambed, trace concentrations of COPCs in the sediment samples indicate erosion of waste materials may have had a minor impact to streambed sediments directly adjacent to waste material. Future erosion of waste materials could continue to impact streambed sediments to a more significant extent than currently observed.
- Groundwater is not present directly beneath most of the waste soils. The nearest groundwater is in the Pilgrim Creek streambed, adjacent to the waste fill. Modeling indicates that benzene may pose a threat to groundwater, although no contamination was detected in the downgradient groundwater monitoring well. Given the relatively long time frame since the placement of waste soils, significant leaching of benzene at detectable concentrations in groundwater is considered unlikely
- The site is currently vacant and undeveloped with no plans for development given its location within an ecologically sensitive area. Military training receptors may occasionally be present in this area although the duration spent in any one location would likely be minimal and the potential for contact with impacted soils relatively low.
- Although the predicted RME risk to a hypothetical nonintrusive worker ($2 \times 10^{-4}$) is at the upper end of the USEPA risk management range (USEPA, 1991b), the site is considered to be protective of human health given the conservative nature of the evaluation and the low potential for development. An institutional control limiting site development may be necessary.

- Lead concentrations in soil at Site 1A-1 ranged up to 9,670 mg/kg. The 95 percent UCL mixed (0 to 10 feet bgs) and surface (0 to 1.5 feet bgs) soil exposure point concentration of 1,200 mg/kg is within the default PRG range of 780 to 1,200 mg/kg.
- The ecological risk assessment concluded that baseline conditions are not protective of ecological receptors at the site. Based on the site-specific tiered ecological risk assessment for Site 1A-1, four chemicals are present in soil at concentrations that are predicted to pose a potentially significant hazard to specific ecological receptors: antimony (invertebrate feeding [invertivorous] birds), lead (invertivorous and omnivorous birds), zinc (invertivorous birds), and dioxins (birds and small mammals). Potentially significant ecological hazards are indicated if concentrations of a chemical at the site result in the estimation of a Tier-2 hazard quotient with a value greater than 1.0. The highest values of the Tier-2 effect-based hazard quotients are 2.3 (invertivorous birds exposed to antimony), 10 (invertivorous birds exposed to lead), 2 (invertivorous birds exposed to zinc), and 64 (omnivorous mammals exposed to dioxins). For other chemicals evaluated in Tier 2 (a total of 37), all Tier-2 effect-based hazard quotients for birds and mammals are less than 1.0. In addition, while there are concentrations of some inorganic chemicals that result in Tier-2 hazard quotients greater than one for terrestrial plant receptors, and for soil organisms and microbial processes, these Tier-2 hazard quotients still rely on Tier-1-level toxicity data (i.e., no-effect toxicological benchmarks).
- Coastal California gnatcatchers were observed at Site 1A-1, and therefore biological resource monitoring may be required during any potential site remediation and/or further investigation activities if conducted during the breeding season.

## 2.2 Development of Remedial Action Objectives

The purpose of this FS is to develop and evaluate remedial action alternatives for each of the OU 5 sites that comply with ARARs, are protective of human health and the environment, and can be implemented in a cost-effective manner.

As discussed in Section 1.4, in accordance with the framework of CERCLA, NCP, and SARA, the RI/FS and subsequent remedial activities conducted at Site 1A-1 must comply with federal and state ARARs. The ARARs/TBC that might apply to Site 1A-1 are discussed in detail in Appendix A. USEPA guidance (USEPA, 1988) requires that remedial action objectives (RAOs) be developed during the initial phase of the FS and be used as the framework for developing the remedial alternatives. The remainder of this section addresses the soil contamination at Site 1A-1 that requires remediation based on the site characterization data collected to date.

### 2.2.1 Chemicals of Concern

As determined in the risk assessments presented in the OU 5 RI Report, antimony, lead, zinc, and dioxins pose a significant risk to ecological receptors at Site 1A-1.

The human health risk assessment concluded that, although the calculated risk under two hypothetical exposure scenarios (intrusive worker and military training receptor) is greater than $1 \times 10^{-6}$, the site is considered to be protective of human health given the conservative nature of the evaluation and the low likelihood of development. The

compounds that have an incremental risk are greater than 1 x $10^{-6}$ excess cancer risk are dioxins and arsenic.

The VLEACH/SUMMERS supplemental vadose zone transport and groundwater mixing modeling results indicated that reported residual VOCs, SVOCs, pesticides, and other COPCs detected in soil do not pose a threat to groundwater. This conclusion is consistent with the generally low concentrations present, the low mobility of many of the COPCs (i.e., pesticides, dioxins/furans, and lead), and their limited vertical extent in soils. No contaminants have been detected in the downgradient groundwater monitoring well located in the Pilgrim Creek streambed.

The above compounds comprise the remedial COCs for Site 1A-1. RGs were established for these remedial COCs as outlined below in Section 2.2.3.

### 2.2.2 Exposure Routes/Receptors of Concern

Sections 2.1.5 and 2.1.6 summarize the exposure routes and receptors of concern.

### 2.2.3 Proposed Remedial Action Objectives and Remediation Goals

The RAOs for the Site 1A-1 soil contamination are defined below:

- Minimize exposure (inhalation/dermal contact/ingestion) to human and ecological receptors to chemicals in soil at concentrations that pose a potentially significant risk
- Protect the beneficial uses and water quality objectives of the San Luis Rey Groundwater Basin.

RGs were developed to meet these RAOs. The derivation of preliminary RGs that are protective of human health are presented in Appendix D. Although the site has a hypothetical risk greater than $1x10^{-6}$, the site is currently considered to be protective of human health for the receptors evaluated in the RI (intrusive and nonintrusive worker, and military training receptor), given the conservative nature of the evaluation and the low likelihood of development. RGs were developed for the two compounds (dioxins and arsenic) that pose a hypothetical risk to human health because if waste soils are removed from the site, these RGs would likely be met.

The derivation of ecological preliminary RGs is presented in Appendix E. In accordance with the US Navy guidance (1999c), the exposure and effects information used in the Tier-2 BERAs were used to develop a range of concentrations for ecological preliminary RGs. The values selected, as a site- and chemical-specific ecological preliminary RG, is the lowest of the ecological preliminary RGs for any wildlife receptor, derived using an effect-based TRV. The site-specific ecological remedial COCs for Site 1A-1 are antimony, lead, zinc, and dioxins.

The supplemental VLEACH/SUMMERS fate-and-transport evaluation presented in Appendix C concluded that reported soil COPCs do not pose a threat to groundwater. Nonetheless, soil RGs for groundwater protection are provided in Appendix C. Average soil RGs are presented in Table C-7. Since benzene and DDD/DDE/DDT are present in a few locations at a maximum soil concentration that exceeds the average soil RG, alternate depth-specific soil RGs were determined taking into account the actual contaminant distribution and depth at these locations. The maximum contaminant concentrations at each depth interval were used. Depth-specific soil RGs are presented

in Table C-8. As shown in this table, significantly higher than average soil RGs can be applied for shallower depths when using alternate depth-specific soil RGs.

Note that the background value for dioxins is taken from the results of numerous scientific studies, which have shown that dioxins and furans occur at trace levels in most soils. Based on a compilation of these studies, the USEPA reported the mean background urban and rural soil concentrations for dioxins (in terms of 2,3,4,8-tetrachlorodibenzo-*p*-dioxin [TCDD] toxicity equivalents [TEQ] and the 1989 International toxicity equivalent factors [TEFs]) of 13.4 and 4.1 nanograms per kilogram (ng/kg), respectively (USEPA, 2000d). Based on this information, and given that the site is located in a non-urban area, the soil background concentration for dioxins is 4.1 ng/kg (0.000004 mg/kg). The RG for dioxin is 17 ng/g.

For each remedial COC, the preliminary RG with the lowest concentration was selected from among the combined receptor preliminary RGs as the final RG. Table 2-1 shows the preliminary RGs and the resulting RG for each remedial COC.

In the event that soils are excavated from the site, confirmation sampling will be necessary as described in detail in Section 2.6.2.4.

RGs were also calculated for an unrestricted land use that would be achieved by meeting the standards of a residential exposure scenario. Note that a residential use of the site is not reasonably expected in the future, and therefore unrestricted land use is not a mandatory goal of cleanup for this site. However, the RGs that would achieve a residential exposure scenario are provided in this document because it is likely that they would be met if waste soils were removed as outlined in the remedial alternatives. The RGs for unrestricted land use are incorporated into Appendix D for reference. If waste soils are ultimately removed, actual confirmation sample results can be compared to these RGs to determine if site cleanup meets the unrestricted land use standard.

## 2.3 Identification of General Response Actions

General response actions (GRAs) represent general classes of technologies that have common characteristics in the way they address the risk posed by contaminated soil (i.e., the RAOs). GRAs considered for Site 1A-1 include the following:

- No Action: No further remedial action for the contaminated soil.
- Institutional Controls: Minimal activity that includes administrative and physical measures to restrict site access with no active remediation of the contaminated soil.
- Containment: Physical measures such as capping to restrict soil contaminant migration (e.g., wind erosion, surface runoff) or waste movement.
- Removal: Removal (i.e., mechanical excavation) of contaminated soil.
- Treatment (in situ and ex situ): Physical, chemical, and biological measures that would reduce toxicity, mobility, or volume of a contaminant or waste by altering the physical or chemical properties of the contaminants and/or media.
- Disposal: Placement of treated or untreated waste soil in a temporary or permanent, pre-engineered, controlled environment (i.e., landfill) that would restrict contaminant migration and eliminate exposure routes.

## 2.4 Identification and Screening of Technology Types and Process Options

The objective of this section is to identify remedial technologies and process options for application for soil remediation at Site 1A-1. This objective is accomplished using a variety of information including previous investigations, remedial actions at other sites, references developed by the USEPA for application at National Priority List (NPL) sites, USEPA computerized technology databases (Alternative Treatment Technology Information Center [ATTIC], Version 1.0; Vendor Information System for Innovative Treatment Technologies [VISITT], Version 2.0; and Hazardous Waste Cleanup Information [CLU-IN]), and standard engineering references.

For each GRA discussed above, one or more potentially applicable remedial technologies were identified. The goal of the screening process is to evaluate a large number of technologies to identify the ones that are potentially implementable for soil remediation and under the specific Site 1A-1 conditions. In this step, both process options and entire technology types can be eliminated based on technical effectiveness and/or implementability considerations. Information on site characteristics and contaminant types and concentrations was used to eliminate technology types and process options that are neither applicable nor effectively implementable at the site.

The remedial technologies identified and evaluated in previous feasibility studies served as the starting point for the list of technology options evaluated in this FS report. These evaluations were revised as appropriate to reflect site conditions and technology updates. In addition, relevant new technologies were included in the evaluation. A summary of the technologies considered in this FS follows:

- Institutional Controls
  - Access Restrictions
  - Fencing
- Containment
  - Capping
- Removal
  - Excavation
- Disposal
  - Landfill
  - Backfilling
- In Situ Physical/Chemical Treatment
  - Soil Flushing
  - S/S
  - In Situ Vitrification
- In Situ Biological Treatment
  - Phytoremediation
- Ex Situ Physical/Chemical Treatment
  - Soil Washing
  - Acid Extraction
  - S/S
  - Chemical Oxidation - Reduction
  - Vitrification
- Ex Situ Thermal Treatment
  - Thermal Desorption
  - Incineration

Figure 2-3 lists the GRAs for the Site 1A-1 soil contamination, identifies the remedial technologies and process types for each response action, and summarizes the screening results for each technology and process. The following sections describe the technologies and process options under each GRA, along with the rationale for retaining or eliminating each technology.

### 2.4.1 No Action

The no action response was retained for consideration during the development and analysis of alternatives as required by the NCP (40 Code of Federal Regulations [CFR] 300.430[e][6]). The no action response does not provide any additional remediation, containment, or security measures to reduce potential risk to human health or the environment at Site 1A-1

### 2.4.2 Institutional Controls

Institutional controls are administrative and physical actions taken to reduce or eliminate risks to public health and the environment by controlling exposure pathways rather than removing contaminants or controlling and reducing their mobility, toxicity, or volume. For soil, institutional controls such as access restrictions and fencing may be considered during the initial screening of technologies to limit exposure of potential human receptors. Institutional controls alone would not be effective because soils at Site 1A-1 pose a risk to ecological receptors and are potentially a long-term threat to groundwater. The reasonably anticipated future land use at Site 1A-1 is neither residential nor industrial given its remote location in an area used for military training. Thus, land use and access restrictions would effectively limit future development and physical access to the site and were retained for further evaluation. Fencing or barriers may be effective in preventing certain ecological receptors (e.g., larger mammals) from accessing the site and contacting site contaminants and was also retained for further evaluation. However, DON's position is to limit the use of institutional controls (where possible) to maximize the utilization of military training lands.

### 2.4.3 Containment

Containment actions for soil contamination are intended to isolate remedial COCs from potential human and/or ecological contact and to protect unimpacted media by reducing or eliminating the migration of remedial COCs from soil to groundwater or surface water systems. The containment option typically is capping (e.g., an asphalt, concrete, or engineered soil cap).

Capping is the process used to cover contaminated materials to prevent their contact with human and ecological receptors. Substantive performance standards for cap design at CERCLA sites include minimum infiltration, low cover maintenance, efficient site drainage, high resistance to damage by settling and subsidence, and low permeability. Caps can be single-layered or multi-layered and come in a variety of designs and materials including asphalt, concrete, or engineered soil caps. The selection of capping materials and cap design are influenced by site-specific factors such as local availability and cost of cover materials, intended function of cover materials, the nature of the waste being covered, local climate and hydrogeology, and projected future use of the site.

Site 1A-1 is located in a vegetated, undeveloped region. The site is at an elevation of approximately 285 to 350 feet amsl and is located in a valley between surrounding hills. The site contains berms and uneven topography apparently resulting from past rough grading operations. The site generally slopes slightly east toward Pilgrim Creek. Currently, the site is undeveloped and vacant, and the Base has no plans to develop the area. Given the physical conditions at Site 1A-1, capping is considered a feasible technology. Asphalt/concrete covers, flexible membrane liners, and engineered soil cover designs were evaluated based on the desired functionality of the cap, and the site

setting and projected future use. Based on the site's projected land use, an asphalt/concrete cap would not be appropriate The site needs to continue to be used for realistic training, and it is also desired that the site maintain a suitable habitat for numerous native plant and animal species. Given the site topography, a flexible liner design would require significant grading of the existing foundation to provide a suitable base and adequate sheet drainage for a flexible liner cover because the differential settlement of the fill material would adversely affect a flexible liner. In addition to the required grading, a top layer of clean soil at least 18 inches thick on top of the liner would be needed to allow sufficient room for vegetation to grow. Based on these considerations, a flexible liner design was found to be no more cost effective and would require more long-term maintenance than an evapotranspiration (ET) soil cover design. Therefore, the engineered soil cover design option is retained for further evaluation. In a semi-arid environment, which is subject to repeated wetting and drying cycles, an ET cover has been found to be more reliable and less subject to desiccation than a cover design with low-permeability soils. Portions of the ET cap located within the floodplain would need to be designed, constructed, operated, and maintained to avoid washout, in order to comply with Resource Conservation and Recovery Act (RCRA) location-specific requirements for hazardous waste TSD facilities located within a 100-year floodplain. Alternatively, portions of the waste within the floodplain could be moved to higher ground where an ET cap would be less subject to flooding

### 2.4.4 Removal

This process option is intended to remove soils containing remedial COCs. The removal option considered for soil at Site 1A-1 is excavation.

Under this process option, the contaminated soil is excavated and removed from the site, and the excavated area is backfilled with clean imported soil and compacted to required standards. Excavation is generally followed by treatment and/or disposal of the contaminated soil. This option is particularly suited for source removal. A frequent practice is to excavate and remove "hot spots" in combination with other measures such as containment (i.e., capping) of less-contaminated soils. Worker health and safety concerns weigh heavily in the decision to remove highly toxic or reactive waste material.

Other factors considered include contaminant mobility, feasibility of on-site containment or in situ treatment, depth of contamination, and the cost of disposing of the waste or rendering it nonhazardous after excavation.

Air monitoring is usually required for this option to demonstrate the effectiveness of dust suppression measures to minimize contaminant exposure potential to workers and off-site receptors. Mechanical excavation using heavy equipment such as a backhoe is feasible at Site 1A-1 because the vertical extent of contamination is very shallow (average depth 8 feet bgs) and covers a relatively small area (approximately 66,700 square feet). However, the potential for degradation of sensitive ecological habitat and worker exposure to contamination from implementing this option exists at Site 1A-1. Appropriate coordination with agencies and implementation of biological monitoring and appropriate mitigation measures would be required. Excavation is readily implementable and was retained for further consideration in evaluating the remedial options for this site

### 2.4.5 Disposal

This GRA involves disposal of excavated contaminated soil in an appropriate landfill. Two process options were considered under this GRA: on-Base landfilling and off-Base landfilling. These two options are evaluated below.

#### 2.4.5.1 On-Base Landfill

This process option involves disposal of excavated soil in an on-Base landfill. There is currently no on-Base Corrective Action Management Unit (CAMU) facility at MCB Camp Pendleton and the designation and/or construction of an on-Base CAMU for the sites addressed in this FS is considered infeasible due to Base land use constraints. Therefore, this option was not retained for further consideration.

#### 2.4.5.2 Off-Base Landfill

Disposal of excavated soil to an off-Base landfill is another process option. Pretreatment of soils would be considered as part of this technology and would be performed at an on-Base transportable treatment unit (TTU) to stabilize the waste soil prior to shipping it to the off-Base disposal facility. Waste characterization testing would need to be performed during excavation to determine whether the soil exhibits hazardous characteristics that would control the selection of an appropriate disposal facility. Disposal of hazardous waste to a landfill has become increasingly difficult and expensive and is regarded as a less desirable option. However, this process option is potentially applicable and was retained for further evaluation.

### 2.4.6 In Situ Treatment

This GRA encompasses remedial technologies and process options that are designed to treat contaminated soil in place. The main advantage of in situ treatment is that it allows the soil to be treated without being excavated and transported to an off-site disposal facility, resulting in significant cost savings. However, in situ treatment generally requires longer timeframes and there is less certainty about the uniformity of treatment because of the variability in soil characteristics and the difficulty in verifying the efficacy of the process. In situ treatment technologies evaluated for contaminated soil at Site 1A-1 fall into two broad groups: physical/chemical and biological. Physical/chemical treatment is typically cost effective and can be completed in shorter timeframes than biological treatment. Some technologies combine both physical and chemical treatment processes.

#### 2.4.6.1 Physical/Chemical Treatment

This process option uses the physical/chemical properties of the contaminants or contaminated media to destroy (i.e., chemically convert the contaminants to innocuous compounds), separate, or contain the contamination. Three process options were evaluated under this GRA: soil flushing, solidification/stabilization (S/S), and in situ vitrification.

##### 2.4.6.1.1 In Situ Soil Flushing

In situ soil flushing extracts the contaminants from soil with water or other suitable aqueous solution. Soil flushing is accomplished by passing the extraction fluid through in-place soils using an injection or infiltration process. Soil flushing uses the contaminant's solubility in liquid to separate it from the soil. Surfactants may be added to the flushing solution to increase the contaminant's solubility. Contaminants are

leached with the extraction fluid into the underlying groundwater, which is then extracted and treated above ground to appropriate standards prior to recycling or release to local publicly owned treatment works (POTWs) or receiving streams. Although this technology appears suitable for treatment of metals in high-soil-permeability conditions similar to those at Site 1A-1, it has no applicability at this site because it would introduce contaminants into the groundwater, which is not a contaminated medium. Therefore, this technology was not retained for further consideration in developing remedial alternatives.

2.4.6.1.2 In Situ Solidification/Stabilization

In situ solidification/stabilization (S/S) reduces the mobility of contaminants in soil through both physical and chemical means. In situ solidification seeks to trap or immobilize contaminants within their "host" medium (i.e., soil), instead of removing them through chemical or physical means. This process option works by changing the physical properties of the contaminated soil, rendering it solid (with high structural integrity), and making the contaminants less prone to mobilization via leaching (USEPA, 1986). The solubility of soil contaminants is reduced by encapsulating the contaminants in a solidifying reagent, thereby reducing the surface area exposed to leaching, and/or by coating the contaminated soil with low-permeability materials (USEPA, 2000b).

In situ stabilization treatment processes are intended to convert contaminants to less mobile forms through chemical or thermal interactions. The addition and mixing of stabilizing agents can be achieved either by flooding the ground surface with a liquid stabilizing agent or by allowing it to percolate into the subsurface and react with the target contaminant. Stabilizing agents in either liquid or dry form also can be introduced and mixed with subsurface soil via auger mixing (USEPA, 1997).

In situ S/S limits the mobility of the contaminants, but it does not reduce contaminant concentrations per se. Its effectiveness is highly dependent on homogenous mixing, which can be difficult to ensure in clay-rich soil environments or where the soil contains significant debris (USEPA, 1997). Grout injection bottom barriers (i.e., impermeable horizontal subsurface barriers) can be used to prevent vertical migration by providing a floor of impermeable material beneath the contaminated soil via directional drilling with forced grout injection. Bottom barriers may be necessary at Site 1A-1 because groundwater fluctuates and may be very shallow at times (encountered at depths as shallow as 0.5 feet bgs at Site 1A, located immediately down gradient of Site 1A-1). In situ technologies also require long-term maintenance, post-cure testing, and implementation of land use restrictions. Because of these limitations, this technology was not retained for further consideration in developing remedial alternatives.

2.4.6.1.3 In Situ Vitrification

This technology treats metal-contaminated soil using heat, usually applied through electrical power, to melt the soil at extremely high temperatures (typically 2,900° to 3,600 degree Fahrenheit (°F). The molten soil forms a stable glass and crystalline structure with very low leaching characteristics that immobilizes the inorganic contaminants by entrapping them or chemically incorporating them in the melt. Because this technology does not destroy many of the metal contaminants but rather traps them inside the matrix, it is often applied to highly concentrated characteristic hazardous waste to meet applicable disposal requirements. There are several disadvantages with this technology. The high temperatures associated with this process produce emissions of toxic vapor from relatively volatile metals (i.e., mercury and lead) that must be captured and treated, the resulting solidified matrix may hinder future site use and necessitate the use of site

access restrictions, implementation entails long-term maintenance, and the technology is energy intensive and costly. Because of these concerns, this technology is impractical for application at Site 1A-1 and was therefore excluded from further consideration.

#### 2.4.6.2 Biological Treatment (Phytoremediation)

Phytoremediation is an emerging technology that uses plants to remove, transfer, stabilize, or degrade chemical contaminants in soil, sediment, or groundwater. There are various applications of phytoremediation technologies; the most appropriate application to Site 1A-1 is enhanced rhizosphere biodegradation, which takes place in the soil immediately surrounding plant roots. Natural substances released by plant roots supply nutrients to soil microorganisms enhancing their biological activity. Plant roots also loosen the soil and then die, leaving paths for transport of water and aeration. This process facilitates the movement of soil moisture to the surface zone.

Research has shown that plants can be used to treat most classes of compounds including metals. Plant species are selected on the basis of their potential to evapotranspirate groundwater, the degradative enzymes they produce, their growth rate and yield, the depth of their root zone, and their ability to bioaccumulate contaminants. Although certain plants allow uptake from deeper zones, phytoremediation is best suited for use in soils that are within 2 to 3 feet bgs and are contaminated with intermediate concentrations of organic waste.

For Site 1A-1, phytoremediation was not judged to be implementable at Site 1A-1 due to limited vertical effectiveness of the technology, the few demonstrated successful applications of this technology to treat heavy metals and dioxins at the observed concentrations, and the fact that it will not eliminate ecological exposure to COCs. Also, it may increase contaminant mobility via plant uptake, making COCs more available and allowing continued long-term exposure to ecological receptors. Also, the concept of excavating the soil to allow use of phytoremediation is not considered cost-effective since the cost of excavation, placement, maintenance, design, construction and operation of an ex-situ phytoremediation treatment system would rival the cost of excavation and disposal. For these reasons, phytoremediation was excluded from further consideration for this site.

### 2.4.7 Ex Situ Treatment

The main advantage of ex situ treatment is that it generally requires less time, and there is greater certainty about the uniformity of treatment because of the ability to monitor and thoroughly mix the contaminated soil. Ex situ treatment, however, requires excavation of the contaminated soil to the ground surface for treatment and subsequent disposal of the treated soil at an appropriate facility or beneficial reuse as fill or construction material. Compared to in situ treatment, these ex situ options lead to increased costs and engineering support for treatment equipment, permitting, and material handling and disposal. Ex situ treatment technologies that were evaluated for metal-contaminated soil at Site 1A-1 fall into two broad groups: physical/chemical and thermal.

#### 2.4.7.1 Physical/Chemical Treatment

Soil washing, acid extraction, S/S, and vitrification were considered as potentially applicable ex situ physical/chemical treatment options for Site 1A-1.

#### 2.4.7.1.1 Ex Situ Soil Washing

Soil washing is a water-based volume reduction process for scrubbing soils ex situ to remove contaminants. This process removes heavy metals from soil by suspending them in the wash solution, or by concentrating them into a smaller volume of soil through particle size or gravity separation. Washing processes that separate the fine clay and silt particles from the coarser sand and gravel particle can effectively separate and concentrate the contaminants into a smaller volume of soil that can undergo further treatment/disposal. The wash water can be augmented with pH adjustment, a leaching agent, or a chelating agent. The contaminated water generated from the process also requires further treatment. Soil washing is generally considered a media transfer technology and is ineffective in achieving cleanup goals when used alone. This process option has seen limited use in the United States. Because of these issues, it was eliminated from further consideration.

#### 2.4.7.1.2 Ex Situ Acid Extraction

Acid extraction uses acidic (hydrochloric acid) reagents to extract heavy metal contaminants from soils. In this process, soil is first mechanically screened to remove coarse solids. Because metals are generally found on the finer soil particles such as clays and humic material, the fine soil particles containing the bulk of the metals are separated in this process, thus considerably reducing the mass of contaminated soil requiring further treatment. Hydrochloric acid is then thoroughly mixed with the separated fine soil in the extraction unit. Residence times generally range between 10 and 40 minutes depending on the soil type, contaminants, and contaminant concentrations. The soil-extraction mix is continuously pumped out of the mixing tank and the soil and extractant separated using hydrocyclones. The resulting "cleaned" soil is then filtered, rinsed, dried, and disposed of or reused. Any residual acid in the treated soil also must be neutralized. The extraction solution and rinse water are typically hazardous and can be regenerated using commercially available precipitants, such as sodium hydroxide (NaOH) or lime, along with a flocculent that removes the metals and reforms the acid. The removed heavy metals are concentrated in a form that is suitable for recovery. These residues often require additional treatment such as S/S or vitrification. Offgases from the process also require collection and treatment. Elevated temperatures associated with the process raise concerns of toxic metallic vapor emissions, which can be difficult to control.

This process option is applicable for organic materials but only partially oxidizes the metals that constitute the soil remedial COCs at Site 1A-1. Meeting stringent heavy metal cleanup criteria (i.e., California wet extraction test [WET]) may prove uneconomical. Capital costs can be relatively high, and the technology is typically economical only at larger sites. In addition, hazards associated with the handling of acids and residues following extraction suggest that implementation of this process option could be difficult. For these reasons, acid extraction was eliminated from further consideration.

#### 2.4.7.1.3 Ex Situ Solidification/Stabilization

Solidification refers to techniques that encapsulate the waste in a monolithic solid of high structural integrity. Stabilization refers to those techniques that reduce the hazard potential of a waste by converting the contaminants into their least soluble, mobile, or toxic form. In ex situ S/S, contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). There are many

innovations of this technology; most of them modifications of proven processes directed at encapsulating or immobilizing the contaminants by processing the contaminated soil. Ex situ S/S is often accomplished by mixing the excavated soil with stabilizing agents or binders, such as pozzolan/Portland cement, phosphate, lime, soluble silicates, sulfur-based additives, or proprietary agents to limit the solubility of metals or detoxify them. Following S/S, the treated soil may be eligible for use as construction fill material. Metals-impacted soil can also be stabilized and recycled by mixing with stabilizing reagents, organic emulsions, and aggregate to form cold-mixed asphalt, which can be used as a commercially viable construction material. This technology was thoroughly evaluated in the OU 4 FS (Parsons, 2003a), and was further investigated by the DON Tiger Team, which ultimately concluded that the technology was infeasible because of the need to ensure that stabilized soils pass the California WET and the need for a large construction project that can utilize large quantities of treated soil

At Site 1A-1, the impacted soil contains locally abundant anthropogenic debris, such as scrap lumber, glass, and other miscellaneous refuse. The effectiveness of stabilization is highly dependent on uniform mixing, which may be difficult to achieve with the debris-laden materials at Site 1A-1. Furthermore, anthropogenic debris, if present in large quantities (which is probable at this site), could require a separate and distinct remedial technology, which would render the cleanup more complicated and costly. For these reasons, this technology is judged impractical for Site 1A-1 and was excluded from further consideration.

#### 2.4.7.1.4 Ex Situ Vitrification

Ex situ vitrification processes are stabilization/solidification methods that employ heat between 1,900° to 3,600°F to melt and convert waste materials into a glass matrix (USEPA, 1997). The high temperatures destroy organic constituents with very few by-products. Inorganics such as heavy metals are incorporated into a stable, relatively strong, and durable glass structure that is very resistant to leaching and has mechanical and chemical properties similar to granite. Vitrification is an energy-intensive and costly technology, not readily implementable, and difficult to ensure homogeneous melting and control emissions of toxic vapors of the relatively volatile metals (i.e., lead) of concern at Site 1A-1. Therefore, this technology is impractical for Site 1A-1 and was excluded from further consideration.

### 2.4.7.2 Thermal Treatment

Thermal processes use heat to increase the volatility (separate); burn, decompose or detonate (destroy); or melt (immobilize) the contaminants. Thermal desorption and incineration were considered as potentially applicable ex situ thermal treatment process options and are evaluated below.

#### 2.4.7.2.1 Ex Situ Thermal Desorption

Thermal desorption is a separation technology that uses heat in a controlled environment to volatilize and remove contaminants from the soil. The technology is not designed to destroy organics. A carrier gas or vacuum system transports volatilized water and organics to an off-gas treatment system. The gas used can be air or an inert gas such as nitrogen. Indirect heating is applied to avoid combustion. The temperature range is usually 300° to 1,200°F (lower than that of incineration), although higher temperatures can be used with an inert gas (USEPA, 1997). Because the operating temperature for this technology is typically far below the boiling point of metals, it is generally ineffective for metals. In addition, volatilization of the relatively volatile metals

(i.e., mercury and lead) and generation of toxic fumes could pose operational and worker safety difficulties. Therefore, thermal desorption was eliminated from further consideration.

2.4.7.2.2 Ex Situ Incineration

Incineration, which can be implemented on or off site, refers to a thermal treatment that destroys organic contaminants by oxidizing them at high temperatures. The two most important parameters for effective destruction of contaminants are temperature and residence time (Freeman, 1989). These two parameters are different for different incineration process designs. The two most commonly used designs are fluidized bed and rotary kiln incinerators. Incineration could be applicable for treatment of organics and diesel contamination, but it is ineffective for treatment of metals because a large percentage of the relatively volatile metals (e.g., lead and mercury) would be emitted as toxic vapors that are difficult to control. Another problem with incineration of metals is that they are not completely destroyed and generally are present in the ash residue, which may require additional treatment and disposal. Finally, because metals have little heat recovery value, system operation is ineffective, costly, and impractical. Therefore, incineration was eliminated from further consideration.

## 2.5 Evaluation of Technology Process Options

Technologies and process options judged to be potentially viable in the previous section for Site 1A-1 contaminated soil are reviewed according to three criteria: effectiveness, implementability, and cost. These criteria are briefly discussed below.

- **Effectiveness.** The effectiveness evaluation focuses on the following elements:
  - Potential effectiveness of process options for handling the estimated areas or volumes of media and meeting the RGs identified in the RAOs
  - Potential impacts to human health and the environment during the construction and implementation phase
  - Reliability and proven effectiveness of the process with respect to the contaminants and conditions at the site
- **Implementability.** The initial technology screening eliminated technology types or process options that were clearly ineffective or unworkable at the site. This evaluation addresses both the technical and institutional feasibility of implementing each process including the following institutional aspects:
  - Ability to obtain necessary permits and rights-of-way for off-site actions
  - Availability of necessary equipment and skilled workers to implement the technology
  - Availability (including capacity) of treatment, storage, and disposal services
- **Cost.** Cost plays a limited role in the screening of technologies at this phase. Relative capital and O&M costs are considered rather than absolute costs. For this evaluation, the cost analysis is based on engineering judgment. Each technique is evaluated as to whether costs are low, moderate, or high relative to other process options in the same technology type. The greatest cost consequences in site remediation are usually associated with the degree to

which different technology types are used. Using different process options within a technology type usually has a less significant effect on cost than the use of different technology types. A technology process option can be eliminated on the basis of cost only if other process options within the same technology type are comparably effective and implementable but have a much lower cost.

Figure 2-4 lists all the technologies and process options that passed the initial screening in the previous section. Based on the above criteria, the process options were evaluated relative to other processes within the same technology type to select a representative process option to be included in a remedial alternative. At this stage of the FS, the emphasis is on the effectiveness of each option; implementability and cost are of lesser importance. Each criterion is rated as low, moderate, or high relative to the technologies within the same process option. The results of the evaluation are discussed in the following sections and are summarized in Figure 2-4.

### 2.5.1 No Action

The evaluation of the no action option for soil contamination at Site 1A-1 is summarized below:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Contaminants would remain in the soil. The effectiveness is rated low because both human and ecological receptors could be exposed to the contaminated soil. RAOs are not achieved. | Low |
| Implementability | No equipment, skilled workers, or permits are required. | High |
| Cost | No cost is associated with no action. | High |

The no action option is retained for incorporation into remedial action alternatives, as required by the NCP, and will be used as a baseline for comparison of other options.

### 2.5.2 Institutional Controls

Access/use restrictions were retained for further evaluation. Access restriction involves limiting site access and future use/development by implementing land use controls in accordance with Department of Defense (DoD) policy.

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Contaminants would remain in the soil. Access restriction would effectively reduce the human health exposure pathway, but it would have very limited effectiveness in protecting ecological receptors. | Low to Moderate |
| Implementability | Readily implementable. However, DON's position is to limit the use of institutional controls (where possible) to maximize the utilization of military training lands | Moderate to High |
| Cost | Low capital or O&M costs. | High |

Access and use restrictions are further retained for incorporation into the remedial action alternatives.

### 2.5.3 Containment

Capping was the containment technology retained after the initial screening phase. Based on the desired functionality of the cap to meet RAOs and the site characteristics, an engineered soil cover was determined to be the only suitable capping option for Site 1A-1. This process option is carried forward for further evaluation.

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Provides adequate overall protection of human health and the environment with a high degree of long-term effectiveness and permanence. Does not include treatment; therefore, does not reduce contaminant toxicity, mobility or volume | Moderate to High |
| Implementability | Necessary equipment, materials, and skilled labor typically available. Only general earthwork is needed for construction. Construction may be difficult because of topography. | Moderate |
| Cost | High capital costs, low O&M costs. | Moderate |

Based on its overall high ratings, this option is retained for incorporation into the remedial action alternatives.

### 2.5.4 Removal

The evaluation of the removal option for soil contamination at Site 1A-1 is summarized as follows:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Demonstrated ability to meet RAOs but it does not reduce contaminant mobility or toxicity without treatment. | High |
| Implementability | Necessary equipment and skilled labor typically available. Requires agency approval, Base coordination, and health and safety (H&S) planning. | Moderate to High |
| Cost | High capital costs, low O&M costs | Moderate |

The removal option is an important strategic option available to support remedial actions at Site 1A-1 and is retained for further consideration in the development of remedial alternatives.

### 2.5.5 Disposal

Disposal of excavated soil to an off-Base landfill was retained from the initial screening phase.

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Demonstrated ability to meet RAOs. Reduces contaminant mobility and toxicity through pretreatment to stabilize waste prior to disposal. | High |
| Implementability | Necessary equipment and skilled labor typically available Off-Base disposal of hazardous waste is considered a worst-case alternative and is becoming an increasingly difficult and expensive option. | Moderate to High |

| Criterion | Evaluation | Rating |
|---|---|---|
| Cost | Off-Base disposal site: High capital and low O&M costs | Moderate |

Disposal to an off-Base landfill is an important strategic technology option available to support remedial actions at Site 1A-1 and is retained for further consideration in the development of remedial alternatives.

### 2.5.6 In Situ Treatment

No in situ treatment technologies were retained after the initial screening phase.

### 2.5.7 Ex Situ Treatment

No ex situ treatment technologies were retained after the initial screening phase.

### 2.5.8 Summary of Process Option Selection

As illustrated in Figure 2-4, all the process options evaluated for remediation of heavy metal contamination in soil at Site 1A-1 are summarized below:

- The no action response is retained as required by the NCP.
- Access/use restrictions and periodic site inspection/monitoring are selected as institutional controls.
- Engineered soil cover is the selected process option for containment.
- Mechanical excavation is the selected process to remove contaminated soil from the site
- Disposal to an off-Base permitted hazardous waste facility was retained as a viable option.

The selected process options provide the basis for the development of alternatives as discussed in the following section.

## 2.6 Development and Detailed Analysis of Remedial Alternatives

Guidance for the development of remedial alternatives for Site 1A-1 was obtained from the following sources:

- 40 CFR 300 (NCP)
- Section 121 of SARA
- Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, 1988)
- Navy/Marine Corps Installation Restoration Manual (U.S. Navy, 1997)

As required by the NCP and recommended by USEPA guidance (USEPA, 1988), acceptable engineering practices that relate to site-specific conditions were considered during development of the remedial action alternatives. The alternatives developed satisfy the requirements of 40 CFR 300.430(e), which specifies that alternatives be developed to include no action, institutional controls, little to no treatment alternatives, and alternatives that reduce the toxicity, mobility, or volume of contaminants, to the extent practical.

The process options selected for Site 1A-1 in the previous section were assembled into specific alternatives representing possible remedies for the soil contamination at the site. Because of the limited number of process options retained for further consideration, few potential remedial alternatives are appropriate for Site 1A-1. Therefore, screening of alternatives was not necessary for Site 1A-1. All the alternatives developed were carried forward into the detailed analysis.

### 2.6.1 Overview of Detailed Analysis and Nine NCP Evaluation Criteria

An overview of detailed analysis and nine NCP evaluation criteria is presented in Section 1.6 of this report.

### 2.6.2 Description of Remedial Alternatives

Alternatives were developed to address the remedial COCs for Site 1A-1 listed in Table 2-1. As illustrated in Figure 2-2, the estimated total area of waste soils is approximately 66,700 square feet. The impacted soils extend to an average depth of 8 feet bgs. The estimated total in-place volume of impacted soil is 20,000 cubic yards.

The following four alternatives were developed for remediation of contaminated soil at Site 1A-1:

- Alternative 1A1-1: No action
- Alternative 1A1-2: Institutional controls
- Alternative 1A1-3: Capping with engineered soil cover and institutional controls
- Alternative 1A1-4: Soil excavation, backfill, pretreatment, and off-Base disposal

A possible fifth alternative for this site is being considered by the Navy, but is not included as a formal alternative in this document at this time pending further review and analysis. The fifth alternative, if determined to be feasible, would involve combining the waste soils from Site 1A and Site 1A-1 and capping the combined waste. If determined to be viable, a supplemental FS would be necessary, which would be reviewed by the FFA Team.

Each of the four alternatives proposed at this time are described in detail in the following sections

#### 2.6.2.1 Alternative 1A1-1: No Action

The NCP (40 CFR 300.430[e][6]) requires that a no action alternative be evaluated. Under this alternative, no further action would be taken to control or clean up the soil contamination at Site 1A-1 to reduce potential risks to human health and the environment. The no action alternative involves no remediation of soils and results in no disturbance to the existing environment.

#### 2.6.2.2 Alternative 1A1-2: Institutional Controls

This alternative implements institutional controls at Site 1A-1 to reduce the risk to human health and the environment by controlling and monitoring exposure pathways rather than removing or controlling the risk source. Institutional controls refer to measures other than engineering control and treatment technologies. The institutional controls in Alternative 1A1-2 include implementing restrictions on the site's future development and

use, as well as periodic site inspection/monitoring of the site to prevent unauthorized use.

The intent of land use restrictions is to limit activities that would increase the potential for exposure of receptors to buried materials. Future use of Site 1A-1 for residential or industrial purposes would be controlled by enforcing these land use restrictions.

To limit erosion and reduce the potential for exposure of human and ecological receptors to the buried materials, the site would be inspected periodically, particularly during the rainy season, for evidence of erosion. If required, measures would be implemented to limit or control site erosion.

Alternative 1A1-2 represents minimal administrative actions and physical measures to restrict site access in order to temporarily reduce and control exposure risks, but it does not involve any active remediation of the contaminated soil to eliminate exposure risk. Site monitoring is expected to continue as long as wastes remain at the site.

If institutional controls, or land use controls, are chosen as the selected remedy for this site, a detailed description of the institutional controls or land use controls will need to be included in the ROD and Remedial Action Plan (RAP). The DON memo titled *Monitoring and Enforcement of Land Use Controls* (U.S. Navy, 2003) provides specific items to be included in the ROD and RAP, including listing the parties responsible for enforcing the land use controls, and the need for five-year reviews.

If institutional controls are selected to be all or part of the remedy for the OU 5 sites, such controls will be implemented by MCB Camp Pendleton as part of the site approval process. Site approval is required for all projects at the Base involving construction, acquisition, or modification. Once site approval is requested, MCB Camp Pendleton Environmental Security must be consulted for environmental approvals, including for National Environmental Policy Act (NEPA) determination if applicable. The form that is used to initiate the site approval process is called the "Preliminary Environmental Data Sheet." Currently Mark Bonsavage is the primary point of contact for projects potentially affecting IR sites. If Mark vacated the position, whoever assumed the roll of IRP Manager would review the site approvals.

The role of Environmental Security in the site approval process includes maintaining a geographic information system (GIS) system for environmental constraints at the Base, including wetlands, sensitive species, and IR sites. If a planned activity requires environmental review or falls within an area specified on the Environmental Operations map, Environmental Security must review the proposed actions and make recommendations.

#### 2.6.2.3 Alternative 1A1-3: Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls

Alternative 1A1-3 consists of an engineered soil cover, (i.e., an ET cover), annual monitoring, O&M, and institutional controls. This alternative includes construction of an approximately 1.5-acre ET cover system. Site 1A-1 is densely vegetated with a grade ranging from 4 to 15 percent. The cap would be designed to provide long-term minimization of infiltration of liquids, function with minimum maintenance, promote drainage and minimize erosion or abrasion of the cover, accommodate settling and subsidence, and have a minimum permeability of $10^{-6}$ cm/s. The implementation of appropriate mitigation measures and coordination with the United States Fish and

Wildlife Service (USFWS) would be required to minimize and avoid habitat disruptions during all site activities.

The ET cover, or cap, would use the natural process of surface runoff, storage, evaporation, and transpiration to control infiltration of water through the cover. The basic profile of the ET cover includes from top of grade to foundation: 6-inch vegetated top soil layer (loosely compacted), 18-inch soil layer at 95 percent compaction, 12-ounce geotextile cushion layer, 12-inch rounded cobble layer, and 2-inch sand layer reinforced with geogrid. Figure 2-5 shows an example of a generalized cross-section of an ET cover.

The topsoil layer promotes vigorous, shallow-rooted plant growth. The underlying compacted soil layer would provide impermeable characteristics with limited water storage for removal by the natural process of evapotranspiration. The geotextile cushion serves as a barrier to keep the compacted soil and cobble layer unconsolidated. The cobble layer minimizes the potential for penetration from burrowing animals and plant roots, thereby protecting local wildlife from exposure to the buried materials below the cap cover system. Soils most suitable for ET covers are those with a high available water retention capacity and an adequate supply of nutrients to support vigorous plant growth. The vegetation most suitable for the ET cover is generally a wide mixture of native grass species with no shrubs or trees so that high transpiration is maintained even under adverse growing conditions and during long-term climactic changes.

In general, ET covers require less maintenance than traditional covers because this type of cover system is inherently self-renewing.

Installing the cap cover system would entail the following steps:

- Clear and grub existing vegetative growth and large boulders/rocks down to the exposed surface soil.
- Grade the existing foundation to the design to provide consistent sheet drainage and earthen swales – the subsequent cap layers would mirror the foundation grade. In the case of Site 1A-1, additional grading may be necessary to ensure that waste materials and new cover soils are placed where they are not subject to significant flooding from Pilgrim Creek.
- Depending on the settling characteristics of the cover soils over the buried materials, install a 12-inch thick cohesionless sand layer over the foundation grade and reinforce with geogrid to provide a stabilized grade for the cap system.
- Place a 1-foot layer of rounded cobbles (3 to 6 inches in diameter) over the existing sand layer. The sand and cobble layers would "day-light" at down-slope areas to allow for any subsurface drainage of rainwater, which may infiltrate into the cobble layer.
- Install a 12-ounce geotextile cushion on top of the cobble layer to keep the overlying compacted soil layer from consolidating into the cobble layer.
- Place 18 inches of clean soil in 6-inch lifts over the geotextile cushion at 95 percent compaction. To minimize damage to the geotextile cushion, the placement of soil would likely have to be completed at the site perimeter while pushing the soil inward to the center of the site.
- Loosely place the last 6-inch layer of vegetative soils to promote vegetative growth.

- Install temporary irrigation piping and sprinkler systems.
- Fertilize and till the top vegetative soil layer.
- Plant/hydroseed native grasses.

To ensure that human health and the environment are protected in the future, the soil cap must not be breached through trenching, excavation, or any other similar activity unless appropriate prior approvals are obtained. Details of the specific O&M requirements would be incorporated into an O&M plan for the cover. This plan would include maintenance activities to preserve or restore the physical integrity of the cap. Maintenance activities may include cleaning earthen drainage channels, removing weeds (including bushes and trees), replacing erosion control materials, and regrading. Also, if significant erosion results from heavy rains, the cover soil may be partially excavated and additional cover soil may be imported, placed, and reseeded. Access roads would be maintained and improved as necessary.

It should be noted that implementing this alternative would disrupt current ecological habitat and will require coordination with Base biologists.

#### 2.6.2.4 Alternative 1A1-4: Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal

Alternative 1A1-4 addresses remediation of contaminated soils exceeding the RGs through excavation, on-Base chemical stabilization, and off-Base disposal. The logistics associated with the implementation of Alternative 1A1-4 including utilities would be addressed in a Remedial Action Work Plan for the site. The siting, location, and excavation for utilities are therefore not discussed in detail in this document. The following elements are associated with Alternative 1A1-4:

- Excavation of impacted soil
- Treatment of a portion of the excavated soil to incorporate chemical stabilizer (Portland cement Type I through V or other appropriate stabilizing agent) by pug mill
- Temporary storage of excavated soil stockpiles
- Sampling and analysis of soil stockpiles for waste characterization
- Transportation of the excavated soil to an off-Base disposal facility
- Confirmation sampling and analysis of excavation areas
- Import and compaction of backfill material
- Site restoration.

Based on the volume of material (approximately 20,000 cubic yards) exceeding the RGs cited in Section 2.1.3.2, approximately 39,000 tons would require excavation from Site 1A-1 (Figure 2-2). Within this area, approximately 66,700 square feet (1.5 acres) is impacted with COCs above site RGs. Based on the data and waste classification discussed in Appendix F1, approximately 9,000 cubic yards (17,550 tons) of the excavated soil would be classified as Resource Conservation and Recovery Act (RCRA) or California-hazardous and would require treatment.

Heavy earthmoving equipment, such as a track-mounted excavator and track- or wheeled- loaders would be used to excavate the impacted soil within the lateral limits.

During soil removal, the excavation would progress vertically and laterally to remove the areas of identified soil contamination exceeding the RGs. The excavation sidewalls would be sloped at 1.5:1 (horizontal:vertical) to maintain slope stability and avoid the use of shoring.

Following excavation to the assumed lateral limits and target depth, confirmation samples would be collected for laboratory analysis. Confirmation sampling would be performed shortly after excavation has been completed, so that, to the extent possible, sampling would be performed concurrent with excavation.

The remedial COCs for this site are metals and dioxins; therefore, confirmation samples would be analyzed for total metals and dioxins, and the results compared to the remedial goals established for the cleanup. Approximately one confirmation sample would be collected from each 40- by 40-foot (1,600-square-foot) area of the excavation. Along the perimeters of the excavation area, some of these samples would be collected from the excavation sidewalls or slopes and from the excavation floor. Based on the analytical results from the confirmation samples and comparison to RGs, the excavation would be extended laterally and/or vertically until the cleanup goals are achieved. If additional excavation were required, additional confirmation sampling and analysis would be performed until the cleanup goals are met.

As described in the OU 5 RI Report, potential human receptors evaluated in the risk assessment for the soil pathways were 1) intrusive worker, 2) nonintrusive worker, and 3) military trainee. The RGs developed in Section 2.2.3 pertain to these same receptor scenarios. If all waste soil is excavated from Site 1A-1, however, it is possible that the resulting residual COCs at the site, after excavation, may not pose a risk to a hypothetical resident. Although there is no anticipated future residential land use at the site at this time, it may be desirable to obtain an unrestricted land use designation following excavation if little additional excavation is required. If it is decided to attempt to document unrestricted land use following removal of waste soils, it will be necessary to calculate risk to human health based on residual concentrations reported in confirmation samples. Such calculations can be conducted "real-time" during site remediation. Although this procedure is not necessary to achieve cleanup to the RGs established in this FS, the project decision-makers can determine if this would be a beneficial exercise during site cleanup if this remedial alternative were chosen. In other words, it may be worth a relatively small additional effort during remediation to achieve an unrestricted land use.

A licensed land surveyor would survey the final spatial limits of the excavation after confirmation sampling and analysis and prior to placement and compaction of backfill. After excavation and confirmation sampling had been completed on a few contiguous grids, placement of backfill and compaction would be initiated. To the maximum extent possible, backfill and compaction would be performed concurrently with excavation and confirmation sampling. Prior to placement of backfill, the exposed bottom of the excavation would be moisture conditioned and the excavation backfilled with imported clean soil. All backfill material would be placed in lifts, moisture conditioned, and compacted. Compaction tests would be performed during the backfill operation to document the percent relative compaction of the soil. Based on the size and shape of the waste fill as defined during the RI, it will likely not be necessary to backfill the excavated area to the original (pre-excavation) surface contours. A large portion of the site could be left unbackfilled and still result in appropriate site drainage and stability. However, it will be necessary to place backfill such that existing roads are maintained and stable. The remedial action/excavation plan would contain details of anticipated cut

and fill areas, but for this FS basic conservative assumptions are made regarding the amount of clean backfill that would be required. Upon completion of backfilling and compaction, the site would be surveyed and revegetated to restore habitat and to minimize erosion.

An on-Base TTU would be used to stabilize the California-hazardous soil to nonhazardous status and the RCRA-hazardous soil chemically to California-hazardous prior to off-Base transport and disposal. None of the material would be classified or manifested as RCRA waste (i.e., would not be "D008-listed" for lead) and would not be subject to the universal treatment standards (UTSs) of the land disposal restrictions (LDRs). Bench-scale and/or pilot testing would be required to determine the proper mixture of soil and Portland cement or other appropriate stabilizing agent. The testing would have to account for variations in soil types and would likely need to be performed both prior to field implementation and as the excavation proceeds.

The chemical stabilization of the soil would be implemented using a vender-supplied TTU, which would consist of a pug mill to mix the reagents (Portland cement or other appropriate stabilizing agent) and soil. A pug mill consists of heavy-duty steel blades arranged on a rotary shaft powered by a high torque engine. The TTU consists of a hopper, screens (to remove unsuitably sized material), conveyor belts between the hopper and pug mill, the pug mill and containment unit, and a conveyor belt equipped with a swinging arm designed to deposit treated soil into discrete 500-ton stockpiles. In using the TTU, the soil would first be placed into the hopper of the treatment unit using the heavy equipment. The screens would then remove particles or clasts with diameters greater than approximately 3 inches. A conveyor belt would then transfer the material to the pug mill for mixing with Portland cement or other appropriate stabilizing agent. The treated soil would then be transferred onto the final conveyor equipped with a swinging arm to deposit the soil into discrete 500-ton stockpiles.

The particles and clasts with diameters greater than 3 inches (i.e., cobbles and/or boulders) would be temporarily stockpiled at the site until remedial efforts are complete. These particles/clasts cannot be placed in the treatment unit and would be washed and reused as backfill at the site or transported off site for disposal. Particles/clasts that are partially cemented soil from the site would be crushed and sent through the treatment unit.

During the remedial action, the excavation, the TTU, and the treated stockpile areas would be delineated with barricades, caution tape, and warning signs to restrict unauthorized access to these areas. Potential exposure and protection procedures for site workers would be addressed in a site-specific health and safety plan. The risk of exposure for site personnel to soil contaminants would be minimized by proper selection of personal protective equipment (PPE); establishing support, contaminant reduction, and exclusion zones; application of suppressants to reduce dust emissions in the excavation and at the TTU and stockpile areas; and monitoring dust using direct-reading instruments. Detailed field procedures for the management and maintenance of an open excavation area and temporary soil stockpile would be provided in the remedial action documents.

A medium-sized tracked excavator (Caterpillar 235 or equivalent) would be used to excavate the soil and place it in small stockpiles adjacent to the working face of the excavation. Large capacity front-end loaders would then transfer the soil from the stockpile to the TTU hopper, which would be located within the exclusion zone and nearby the excavation. Plastic sheeting would be required to protect the ground surface

beneath the hopper and the swinging arm of the conveyor belt (depositing the treated 500-ton stockpiles). Each treated stockpile would remain on the plastic, to protect underlying soils, until it was transported off Base. The ability of the treated soil to produce fugitive dust would be greatly diminished because the cured Portland cement or other appropriate stabilizing agent would act to bind the soil particles and reduce dust emissions. The stockpiles would be periodically wetted and regularly monitored to ensure control of fugitive dust emissions. The water applied during dust control activities would be applied in a fashion so as to eliminate the potential for erosion. Stockpiles would be in continuous motion during excavation, treatment, and loading of materials for disposal. However, at the end of each day, stockpiles would be covered with Visqueen (plastic) sheeting and secured with sand bags.

Prior to transport, composite stockpile samples would be collected and the analytical results would then be used to characterize and classify the waste. Based on topographic maps of the area immediately surrounding the site, sufficient open space is available near the excavations to operate the TTU and serve as a staging area for the treated stockpiles. Based on the throughput of the TTU, this alternative would proceed at an average rate of approximately 400 cubic yards (600 tons) per day. However, impacted material will be excavated in advance of the mobilization of the TTU to limit the number of work days. The cost estimate in Appendix F1 is based on a 5-day work week (8 hours per day), resulting in 182 calendar days (or approximately 26 weeks).

In preparing this alternative, soil that would be excavated and eventually treated was first subjected to a waste classification procedure based on the RI data (Appendix F1). However, if this alternative were implemented, then waste classification (prior to manifesting, transport, and disposal) would need to be determined based on the results of post-treatment stockpile sampling and analysis. Based on the concentrations of compounds detected at the site, only lead and pesticides have concentrations that would exceed hazardous waste characterization/classification levels. Therefore, stockpile samples would be analyzed for soluble lead and pesticides by the following two test procedures: the toxicity characteristic leaching procedure (TCLP) (SW1311), as described in USEPA Publication SW 846, and the California WET analysis (22 CCR Chapter 11). The results for the WET analyses would be compared to the soluble threshold limit concentrations (STLCs) to determine if the waste classifies as California hazardous. Likewise, the results from the TCLP tests would be compared to the TCLP criteria to determine if the waste classifies as RCRA hazardous. Using these results and appropriate regulations governing classification of hazardous waste, each 500-ton soil stockpile would be classified as RCRA-hazardous, California-hazardous, or nonhazardous waste. Logistic considerations permitting, it may be possible to perform some of the testing in an iterative manner so that the results from WET analyses would be compared to STLC levels prior to analysis by TCLP.

For estimating purposes, it is assumed that, upon excavation and treatment, all nonhazardous soil would be transported to the Waste Management Bradley Facility in Tujunga, California, and all California-hazardous soil would be transported to Waste Management's Kettleman Hills Facility in Kettleman City, California for disposal. However, it is also possible that treated waste soils could be transported by train to a different facility, possibly out of state. If excavation and off-Base disposal is chosen as the preferred remedial alternative, cost savings may be achieved by modes of transport other than trucking, such as use of trains for all or part of the transport. Also, it is possible that cost savings may be achieved if multiple sites are addressed at the same time. For the purposes of the cost estimate in this FS, however, all soil excavation and

disposal is assumed to be on a site-by-site basis, and that trucking of waste will be the exclusive means of transport. This allows for a direct comparison of costs between sites using the same set of assumptions.

All hazardous soils (RCRA and California hazardous) would be transported under Uniform Hazardous Waste Manifest to the appropriate disposal facility. All nonhazardous soils would be transported under Bills of Lading. All required placards would be placed on vehicles prior to leaving the site. All federal and California Department of Transportation (DOT) guidelines and regulations would be followed. Each transport truck is expected to haul approximately 18 cubic yards (23 tons) of soil to the disposal facility. To ensure that trucks do not exceed the public highway weight limits, calibrated portable scales would be placed on site and operated by a certified weigh master. An average rate of 15 minutes per transport truck is estimated for loading, weighing, and tarping; therefore, 32 trucks could be loaded in each 8-hour shift. However, this exceeds the 600-ton daily capacity of the TTU day, so that only approximately 25 trucks would be needed per shift.

The total duration of the remedial action is expected to be 26 calendar weeks, based on an excavation and treatment rate of 400 cubic yards (600 tons) per day and concurrent transportation and disposal at a rate of 1,000 tons per day. The mobilization would require 1 week. Excavation, treatment, stockpiling (including sampling), and transportation would require approximately 17 weeks. Confirmation sampling and analysis would extend approximately 2 weeks beyond the excavation, assuming laboratory turn-around times of 1 week. After all excavation and confirmation sampling/analysis are complete, backfill and compaction would extend approximately another 2 weeks. Site cleanup and restoration (final grade check, surveying, and revegetation) would require another 4 weeks.

It should be noted that implementing this alternative would disrupt current ecological habitat and will require coordination with Base biologists.

### 2.6.3 Detailed Analysis of Site 1A-1 Remedial Alternatives

This section presents a detailed analysis of the four remedial alternatives that were developed for Site 1A-1. The detailed analysis of remedial alternatives consists of evaluating each selected alternative against seven of the nine NCP evaluation criteria (state and community acceptance will be evaluated in the future). The objective of the detailed analysis is to present and interpret the relevant information necessary to select the most appropriate and cost-effective remedy for a site to meet the RAOs. The detailed analysis is designed to provide decision-makers with sufficient information to compare the alternatives, select an appropriate remedy for the site, and demonstrate conformance with the CERCLA remedy selection requirements in the ROD (Table 2-2). All four alternatives for Site 1A-1 were selected for the detailed analysis.

#### 2.6.3.1 Overall Protection of Human Health and the Environment

An analysis of how well each alternative meets overall protection of human health and the environment is provided below.

Alternative 1A1-1: No Action

The no action alternative includes no treatment and no control of exposure pathways. Under this alternative, the potential long-term risks would be the same as those calculated in the baseline HHRA and the ecological risk assessment and would not be protective of environmental receptors. Fate-and-transport modeling results for Site 1A-1

indicate that existing contamination in the soil could pose a threat to groundwater in the future. The site is also partially located in the floodplain and the waste soils could be transported downstream during a heavy surface-water-flow event. Based on the site conditions, the no action alternative would not be protective of the environment.

The no action alternative includes no treatment and no control of exposure pathways. Under this alternative, the potential impacts to human health would be the same as those calculated in the baseline human health risk assessment.

Alternative 1A1-2: Institutional Controls

Under current conditions, Alternative 1A1-2 would provide for control of exposure pathways through land use restrictions and periodic site inspections and monitoring. However, because the site is located in a stream valley, contaminants could eventually wash out and potentially impact surface soil and water if the area is flooded. Therefore, this alternative would provide only limited protection to the environment since ecological receptors could still come in contact with contaminated surface and near-surface soils in the event of a flood. Fate-and-transport modeling results for Site 1A-1 indicate that existing contamination in the soil could pose a threat to groundwater in the future.

Alternative 1A1-3: Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls

This alternative would to provide overall protection of human health and the environment by effectively reducing the availability of contaminated soil to receptors and eliminating exposure pathways to the contaminated soil. In addition, institutional controls would limit future site receptors and monitoring requirements would ensure the integrity of the cover to limit any receptor contact with subsurface contamination.

Alternative 1A1-4: Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal

Alternative 1A1-4 would protect human and ecological receptors because all contaminated soil exceeding chemical-specific RGs would be physically removed, transported off Base, and partially backfilled with clean import soil as appropriate. Residual contamination would meet RGs and would therefore be protective of human health and the environment.

#### 2.6.3.2 Compliance with ARARs

An analysis of how well each alternative complies with ARARs is provided below.

Alternative 1A1-1: No Action

No action-specific ARARs are identified for the no action alternative because no action is taken. Based on the previously performed screening-level ERA, Alternative 1A1-1 would not comply with location-specific requirements of the Endangered Species Act and RCRA requirements for sites located within a floodplain. In addition, Alternative 1A1-1 would not comply with site-specific water quality objectives and beneficial uses since the site is partially located within a floodplain.

Alternative 1A1-2: Institutional Controls

Because elevated levels of COCs would remain at the site, post-closure care is required. Alternative 1A1-2 partially meets this requirement by providing use restrictions and site monitoring/maintenance for surface soil erosion. Based on the previously performed screening-level ERA, Alternative 1A1-2 would not comply with location-specific requirements of the Endangered Species Act and RCRA requirements for sites located

within a floodplain. In addition, Alternative 1A1-2 would not comply with site-specific water quality objectives and beneficial uses since the site is partially located within a floodplain.

Alternative 1A1-3: Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls

Alternative 1A1-3 would comply with ARARs, including air permitting, waste pile, and capping requirements for hazardous waste. Alternative 1A1-3 would meet requirements for discharge of visible emissions during excavation/construction, requirements for stockpiling and covering of disturbed soils during foundation grading, and requirements associated with cap design and maintenance and groundwater protection. It is likely that Alternative 1A1-3 would comply with action- and location-specific requirements of the Endangered Species Act, although coordination with the USFWS would be required. In addition, portions of the cap located within the floodplain would be designed, constructed, operated, and maintained to avoid washout, in order to comply with RCRA location-specific requirements for hazardous waste TSD facilities located within a 100-year floodplain.

Alternative 1A1-4: Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal

Alternative 1A1-4 would comply with ARARs, including air permitting, waste pile, and RCRA requirements for hazardous waste treatment, storage, and disposal. The clean closure requirements in 22 CCR 66264.111 (a) and (b) are met by excavating soils with concentrations of contaminants in excess of the proposed remediation cleanup goals. The historical and cultural resources protection requirements of 36 CFR 800.3 and 800 4 and 32 CFR 229.1 are identified as potential ARARs. Although no resources are known to exist at the site, excavation activities would be monitored for potential identification of unknown cultural resources because these resources have been recorded in the area. San Diego Air Pollution Control District (APCD) Rule 50(d)(1) is an ARAR for the discharge of particulate matter via fugitive dust emissions during excavation, handling, and transportation activities. Soils would be wetted and covered with a synthetic material or soil polymer to meet the air requirements.

It is likely that Alternative 1A1-4 would comply with action- and location-specific requirements of the Endangered Species Act, although coordination with the United States Fish and Wildlife Service (USFWS) would be required. Additional coordination with State Historic Preservation Officer (SHPO) and appropriate Native American groups would be needed to comply with the Archeological and Historic Preservation Act.

#### 2.6.3.3 Long-Term Effectiveness and Permanence

An analysis of the long-term effectiveness and permanence for each alternative is provided below.

Alternative 1A1-1: No Action

The risks associated with the no action alternative were evaluated in the baseline human and ecological risk assessments. This alternative would not provide actions or controls to reduce existing contaminant concentrations or risks to human health or the environment. As a result, the reliability and adequacy of actions or controls is not evaluated for no action. No action is not considered to provide long-term effectiveness and permanence because contaminated material would remain at the site. The site is located in the floodplain and no action also does not prevent the possible erosion of existing waste soils.

Alternative 1A1-2: Institutional Controls

This alternative would be effective in controlling potential human exposure to buried material and would limit future site development. However, there would be little effectiveness in protection of ecological receptors. Alternative 1A1-2 would require long-term maintenance and would provide a small degree of effectiveness through limiting exposure and site uses. However, given the site's location within the floodplain and the potential for flooding to expose contaminated soils, this alternative does not provide long-term effectiveness and permanence for human or ecological receptors.

Alternative 1A1-3: Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls

Alternative 1A1-3 provides moderate to high long-term effectiveness and permanence by limiting potential receptor contact with contamination through both an engineered cover and land-use restrictions. The long-term effectiveness would depend on proper monitoring and maintenance of the cap. Annual O&M of the cap consists of periodic watering and weed removal (including any bushes or trees), repair as necessary and appropriate to ensure integrity, laying down additional topsoil cover as necessary, and annual detailed inspections. Vegetation on the cap must be maintained to reduce the potential for cap erosion and penetration below the cobble/sand layers. A monitoring, maintenance, and inspection program would be developed and specified in the remedial action plan (RAP). Adherence to the program would help ensure long-term integrity and effectiveness of the cap. Land use restrictions would be needed to effectively preclude any excavation and trenching, as well as residential, agricultural, or any development in the cap area. A 50-year life expectancy has been assumed for the cap.

Alternative 1A1-4: Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal

This alternative would provide a high degree of long-term effectiveness and permanence because contaminants are removed from the site and the contaminated soil is partially replaced with clean import soil. The excavation of contaminated soil provides a permanent solution for protecting human and ecological receptors, and results in an adequate and reliable reduction of exposure pathways. This alternative satisfies the RAO. Removal and off-site disposal of the contaminated soil would result in acceptable levels of residual soil contamination from both a human and ecological perspective, and would also provide future protection of groundwater.

#### 2.6.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

An analysis of the reduction of toxicity, mobility, or volume through treatment for each alternative is presented below.

Alternative 1A1-1: No Action

Because active treatment is not a component of this alternative, there is no reduction in toxicity, mobility, or volume of soil through treatment.

Alternative 1A1-2: Institutional Controls

Because treatment is not a component of this alternative, there is no reduction in toxicity, mobility, or volume of soil through treatment.

Alternative 1A1-3: Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls

The mobility of the contaminated soil would be reduced by installation of a cap to inhibit contaminated surface water runoff, infiltration, and potential downward leaching of contaminants to groundwater, but because treatment is not a component of this alternative, there is no reduction in toxicity or volume of soil through treatment.

Alternative 1A1-4: Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal

Alternative 1A1-4 involves chemical stabilization of the soil on Base prior to off-Base transport and disposal. Although an increase in volume of soil is realized, there is a moderate reduction in toxicity and mobility observed with this alternative.

2.6.3.5 Short-Term Effectiveness

An analysis of the short-term effectiveness for each alternative is provided below.

Alternative 1A1-1: No Action

No remedial actions would be implemented under the no action alternative; therefore, effectiveness during implementation cannot be evaluated.

Alternative 1A1-2: Institutional Controls

Implementation of use restrictions is administrative and presents no short-term effectiveness issues. Implementation of Alternative 1A1-2 is not expected to result in any significant adverse environmental impacts, aside from the continued long-term risk posed by site contaminants to ecological receptors. Site 1A-1 has already been disrupted by episodic vehicle traffic and implementation of Alternative 1A1-2 would not result in any significant impact to vehicle traffic in the area of the site.

Alternative 1A1-3: Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls

The short-term effectiveness for Alternative 1A1-3 is rated moderate. Movement of construction equipment over the contaminated soil could create a potential for short-term risk to site workers due to exposure to contaminated soil, including inhalation of fugitive dust, dermal contact, and ingestion of impacted site soil during cap construction. Dispersion of fugitive dust and particulate matter would be controlled by appropriate dust suppression measures during clearing/grubbing and foundation grading operations. A site-specific health and safety plan would be prepared and implemented. Potential exposure and protection procedures for workers would be addressed in the health and safety plan.

Heavy equipment operated at the site would conform to California Occupational Safety and Health Administration (Cal/OSHA) specifications and would be operated only by authorized, trained personnel. Traffic accidents associated with driving public highways could occur in the course of soil transportation. Risks associated with exposure of site personnel and nearby receptors to dust emissions and/or direct contact with contaminated soil during would be minimized by using dust suppressants and/or appropriate personal protective equipment, where applicable.

Implementation of Alternative 1A1-3 would not result in any significant long-term, adverse impacts to ecological resources although short-term disruption of habitat will occur. The impacts to ecological receptors and habitat would be minimized through close coordination with the appropriate regulatory agencies (i.e., USFWS) including

implementation of appropriate monitoring and mitigation requirements. The areas affected during remediation would be revegetated following completion of the remedial alternative.

Alternative 1A1-4: Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal

The short-term effectiveness for Alternative 1A1-4 is rated moderate. A site-specific sampling plan as well as a site-specific health and safety plan would be prepared and implemented. Potential exposure and protection procedures for workers would be addressed in the health and safety plan. Potential short-term risks to site workers would include inhalation of fugitive dust, dermal contact, and ingestion of impacted site soil during excavation and pretreatment.

Heavy equipment operated at the site would conform to Cal/OSHA specifications and would be operated only by authorized, trained personnel. The contaminated soil would be transported to the selected off-Base disposal facility in covered trucks traveling on public highways. Prior to leaving the site, trucks would be thoroughly inspected to ensure that no loose contaminated soil, which could present a hazard to the public, is present on the outside of the trucks. Traffic or train accidents could occur in the course of soil transportation. In the case of an accident, the risk to the public would be from exposure to dust from contaminated soil, in addition to the risk of physical harm due to the accident. Risks associated with exposure of site personnel and nearby receptors to dust emissions and/or direct contact with contaminated soil during excavation and stockpiling would be minimized by using dust suppressants and/or appropriate PPE, where applicable.

Implementation of Alternative 1A1-4 is not expected to result in any significant adverse environmental impacts. The area in Site 1A-1 subject to remediation has already been disrupted by episodic vehicle traffic. Some short-term impacts to ecological receptors and habitat could occur, but adverse effects would be minimized through close coordination with the appropriate regulatory agencies (i.e., USFWS). The areas affected during remediation would be revegetated following completion of the remedial alternative.

Field personnel participating in the excavation, treatment, and sampling activities would wear PPE, as specified in the health and safety plan. The remedial activities in this alternative are expected to be completed in less than 1 year.

2.6.3.6 Implementability

An analysis of the implementability of each alternative is provided below.

Alternative 1A1-1: No Action

No implementability concerns are posed by this alternative because no action would be taken.

Alternative 1A1-2: Institutional Controls

Institutional actions comprising this alternative are readily implementable. Implementing Land Use Controls are administrative in nature. The Base would have primary responsibility for implementing this alternative and possesses the authority and capability to establish appropriate safeguards and to monitor and enforce compliance. Existing staff within the Base Environmental Security Office coordinate all on-Base construction activities to ensure appropriate environmental review. Institutional controls for IR sites are maintained on a central GIS that is readily accessible. Furthermore, the

5-year review process provides an additional level of review to ensure that the site is not used inappropriately.

Implementation of Alternative 1A1-2 would require coordination with the USFWS to ensure that this alternative would be protective of ecological receptors and complies with requirements of the Endangered Species Act. Based on the previously performed screening-level ERA, it is unlikely that these agencies would allow this alternative to be implemented because it would not be protective of ecological receptors. In addition, the DON's position is to limit the use of institutional controls (where possible) to maximize the utilization of military training lands.

Alternative 1A1-3: Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls

Implementability is ranked moderate for Alternative 1A1-3. The construction techniques required for capping are well established. This alternative uses standard and readily available labor skills and cap construction equipment and supplies. Soil, sand, cobbles, and geosynthetic materials required for the cap are locally and regionally available. A Nationwide Permit 38 from the Army Corps of Engineers would likely apply to the project and would preclude a requirement for individual Section 404 permit regulating the discharge of "dredge and fill" material.

Implementation of Alternative 1A1-3 would require coordination with the USFWS to ensure that this alternative is protective of ecological receptors and complies with requirements of the Endangered Species Act. This review process would take 6 to 12 months and would require implementation of appropriate mitigation measures to minimize habitat disruptions during earthmoving activities, including scheduling limitations on excavation work, performance of short-term biological monitoring prior to, during, and after construction activities, and long-term biological monitoring and habitat restoration measures. In addition, portions of the ET cap located within the floodplain would need to be designed, constructed, operated, and maintained to avoid washout, in order to comply with RCRA location-specific requirements for hazardous waste TSD facilities located within a 100-year floodplain. Alternatively, portions of the waste within the floodplain could be moved to higher ground where an ET cap would be less subject to flooding.

As stated above for Alternative 1A1-2: Institutional Controls, close coordination with on-Base tenants would be required to ensure that no military training occurs in this area. In addition, the 5-year review process would be required.

Alternative 1A1-4: Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal

Implementability is ranked high for Alternative 1A1-4. Excavation and disposal of contaminated soil at an off-Base disposal facility are readily implementable. Several firms can provide the necessary equipment, materials, and labor to excavate and dispose of the contaminated soil. Licensed disposal facilities capable of accepting the contaminated soil currently exist within California.

Because the majority of the impacted soil would be permanently removed from the site, future soil remedial activities are not expected to be necessary. Collecting and screening confirmation samples during excavation would be used to evaluate the effectiveness of soil excavation.

Implementation of Alternative 1A1-4 would require coordination with the USFWS to ensure that this alternative would be protective of ecological receptors and complies with

requirements of the Endangered Species Act. In addition, cultural resources coordination (SHPO and Native American groups) will be required. This review process would require implementation of appropriate mitigation measures to minimize habitat disruptions during earthmoving activities, including scheduling limitations on excavation work, performance of short-term biological monitoring prior to, during, and after construction activities, and long-term biological monitoring and habitat restoration measures.

2.6.3.7 Cost

A summary of the costs is provided below.

Alternative 1A1-1: No Action

No costs are associated with Alternative 1A1-1.

Alternative 1A1-2: Institutional Controls

The total cost of Alternative 1A1-2 is estimated to be $295,000. This cost covers the administrative costs for implementation of use restrictions and future inspection/reporting costs of the site surface, annual reporting costs, and 5-year review with subsequent reporting. If institutional controls were implemented, there would be indirect costs associated with the Base not being able to use the property for training and other purposes. This potential loss of land use is not quantified in this document, but is considered as a factor in evaluating implementability of institutional controls as a remedial alternative. A cost estimate, including inspection/reporting costs, is provided in Appendix F1.

Alternative 1A1-3: Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls

The capital cost for design and construction of the cap system is estimated at $1,010,000; the operation and maintenance cost (2004 dollars) is estimated at $1,565,000, for a total of $2,575,000. The detailed cost analysis was prepared using an underlying set of assumptions as presented in Appendix F1.

Alternative 1A1-4: Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal

The cost for Alternative 1A1-4 is estimated at $8,062,600. This cost includes the required equipment, materials, and labor to perform site preparation, including construction of the soil stockpile area; excavation, backfilling with clean soil, and stockpiling; on-Base pretreatment of all excavated soil to incorporate chemical stabilizer; confirmation sampling and laboratory analysis; waste characterization; transportation and disposal of contaminated soil at a California hazardous waste disposal facility; surveying; and site restoration. A breakdown of the cost estimate is provided in Appendix F1.

## 2.7 Comparative Analysis of Alternatives

This section provides a comparative evaluation of Alternatives 1A1-1 through 1A1-4 relative to the NCP criteria and discusses the relative advantages and disadvantages of the alternatives.

### 2.7.1 Overall Protection of Human Health and the Environment

Alternative 1A1-1 would leave contaminant concentrations in place that pose a potential threat to ecological receptors. Alternative 1A1-2 would control human exposure pathways. Alternative 1A1-3 would protect ecological receptors by capping the impacted soils and using institutional controls, effectively eliminating potential exposure pathways. Alternative 1A1-4 would protect ecological receptors through removal and disposal of impacted soils in an appropriate off-Base disposal facility.

### 2.7.2 Compliance With ARARs

Based on the screening-level ERA, Alternatives 1A1-1 and 1A1-2 would not comply with location-specific requirements of the Endangered Species Act and RCRA requirements for sites located within a floodplain. Alternative 1A1-4 would comply with ARARs for excavation, waste piles, transportation, and disposal. It is likely that Alternatives 1A1-3 and 1A1-4 would also comply with action- and location-specific requirements of the Endangered Species Act, although coordination with the USFWS would be required. Alternative 1A1-4 would comply with RCRA clean closure requirements.

### 2.7.3 Long-Term Effectiveness and Permanence

Alternative 1A1-1 is rated low for long-term effectiveness and permanence because no measures or controls are associated with this alternative. Alternative 1A1-2 would require long-term maintenance. Alternative 1A1-2 would provide a degree of long-term effectiveness through limiting exposure and site uses although the potential exists for contaminant migration during flooding events. Alternative 1A1-3 would provide a higher degree of long-term effectiveness through elimination of exposure pathways via capping in addition to restricting site uses. Alternative 1A1-4 would provide the greatest degree of long-term effectiveness and permanence because it involves removal of the contaminated soils from the area and backfilling of the excavation with clean import soil. For Alternative 1A1-4, the measures and controls implemented would effectively reduce the potential for future human exposure, and no further actions (e.g. institutional controls) would be necessary.

### 2.7.4 Reduction of Mobility, Toxicity, or Volume Through Treatment

Alternatives 1A1-1 and 1A1-2 are rated low for this evaluation criterion because they do not involve treatment. Alternative 1A1-3 would reduce contaminant mobility but does not involve treatment and is therefore ranked low. Alternative 1A1-4 includes on-Base stabilization pretreatment prior to disposal to limit the leachability of contaminants. Stabilization reduces the mobility and toxicity of contaminants but increases the overall volume of resulting treated soil; therefore, this criterion is rated moderate for Alternative 1A1-4.

### 2.7.5 Short-Term Effectiveness

This criterion is not rated for Alternative 1A1-1 because it does not involve any actions that would disturb the site. The short-term effectiveness of Alternative 1A1-2 is ranked high and is expected to be the greatest of the four alternatives. Minimal site activities are planned. The potential for short-term dust exposure exists during cap construction for Alternative 1A1-3 and during excavation and transportation to an off-Base disposal facility for Alternative 1A1-4. Alternatives 1A1-3 and 1A1-4, which are ranked moderate, could result in short-term impacts to ecological receptors although impacts would be minimal if appropriate regulatory coordination occurs, including implementation of any

required mitigation and monitoring measures during construction. Also, Alternatives 1A1-3 and 1A1-4 have potential worker safety issues including possible accidents associated with transportation of waste soils.

### 2.7.6 Implementability

This criterion is not rated for Alternative 1A1-1 because no activities would be conducted under this alternative. Alternatives 1A1-2, 1A1-3, and 1A1-4 are readily implementable and involve commonly performed remedial operations. Alternative 1A1-2 is considered easier to implement because activities are largely administrative. However, given that the Base mission is to support training, any area with a land use restriction would limit that function and this potential loss of land use causes Alternative 1A1-2 to be rated moderate.

Equipment, materials, and labor for Alternatives 1A1-3 and 1A1-4 are easily available, and both alternatives involve commonly performed remedial operations. Alternative 1A1-3 is ranked high although it would require significant coordination with the regulatory agencies. Excavation and treatment for Alternative 1A1-4 use standard equipment and labor skills and are readily implementable. Stabilizing reagents range from widely available off the shelf reagents, such as fly ash, cement, etc., to less common, more specialized proprietary reagents. Alternative 1A1-4 is ranked high because all components of this alternative are readily implementable.

### 2.7.7 Cost

No cost is associated with Alternative 1A1-1. Alternative 1A1-2 is less expensive than Alternatives 1A1-3 and 1A1-4, with an estimated cost of $295,000. Alternative 1A1-3 provides a medium cost alternative with a cost of approximately $2,575,000. Alternative 1A1-4 is the most expensive remedial alternative for Site 1A-1, with an estimated cost of $8,062,600.

### 2.7.8 Summary of Comparative Analysis

The results of the comparative analysis for Site 1A-1 are summarized below.

| Criteria | Alternative | | | |
|---|---|---|---|---|
| | 1A1-1[a] | 1A1-2[b] | 1A1-3[c] | 1A1-4[d] |
| **Threshold Criteria** | | | | |
| Overall Protection of Human Health and the Environment | No | No[e] | Yes | Yes |
| Compliance with ARARs | No | No | Yes | Yes |
| **Balancing Criteria** | | | | |
| Long-Term Effectiveness and Permanence | Low | Low | Moderate to High | High |
| Reduction of Toxicity, Mobility, or Volume by Treatment | Low | Low | Low | Moderate |
| Short-Term Effectiveness | Not Rated | High | Moderate | Moderate |
| Implementability | Not Rated | Moderate | Moderate | High |
| Cost ($ million) | 0 | 0.30 | 2.58 | 8.06 |

[a] No Action
[b] Institutional Controls
[c] Capping with Engineered Soil Cover and Institutional Controls
[d] Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal
[e] Institutional controls would be protective of human health but not protective of ecological receptors

Alternative 1A1-1 does not meet ARARs and would not be protective of the environment. Alternative 1A1-1 also does not provide long-term effectiveness and permanence. No costs are associated with Alternative 1A1-1.

Alternative 1A1-2 would be protective of human health through use restrictions but would not be protective of ecological receptors. The potential for longer term adverse ecological impacts is increased due to the site's vulnerability to flooding, which could mobilize or expose subsurface soil contamination that is not currently available for contact with ecological receptors.

Alternatives 1A1-3 and 1A1-4 would be protective of human health and the environment, meet ARARs, and provide a high degree of long-term effectiveness and permanence. Alternative 1A1-3 provides long-term effectiveness through elimination of exposure pathways via capping. Alternative 1A1-4 would be the only alternative for which reduction of toxicity, mobility, or volume by treatment would be demonstrated, via some pretreatment prior to disposal. Alternative 1A1-4 has the highest ranking for implementability.

The cost to reduce the ecological risks and exposure pathways associated with site metals, with restricted land use, is estimated to be $295,000 for Alternative 1A1-2. To achieve a higher level of protectiveness and unrestricted future land use, Alternative 1A1-3 would require overall costs of approximately $2,575,000 and Alternative 1A1-4 overall costs of approximately $8,062,600.

# Table 2-1
# Site 1A-1 Proposed Remediation Goals
# MCB Camp Pendleton, California

| Contaminant of Concern | Maximum Concentration | Background Concentration [a] 0 to 5 feet | HHRA Preliminary Remediation Goal [b] | | ERA Preliminary Remediation Goals [c] | Proposed Remediation Goal |
|---|---|---|---|---|---|---|
| | | | California Modified Toxicity Data | USEPA Toxicity Data | | |
| **Dioxins/Furans (ng/kg)** | | | | | | |
| 2,3,7,8-TCDD TEQ | 2,700 [d] | 4.1 | 20 | 17 | 44 | 17 |
| **Inorganics (mg/kg)** | | | | | | |
| Antimony | 110 | 8.8 | -- | -- | 16 | 16 |
| Arsenic | 28 | 4.6 | 1.8 | 1.8 | -- | 4.6 [e] |
| Lead | 9,700 | 29.1 | -- | -- | 73 | 73 |
| Zinc | 8,700 | 111 | -- | -- | 254 | 254 |

a = Santa Margarita Basin Background (SWDIV, 1997)
b = The HHRA Preliminary RG with the lowest concentration was selected from among the combined receptor Preliminary RGs (as derived in Appendix D) as the final RG for each COC.
c = The value selected, as a site- and chemical-specific Ecological Preliminary RG, is the lowest of the Ecological Preliminary RGs for any wildlife receptor, derived using an effect-based TRV (Appendix E)
d = Calculated toxicity equivalent for humans
e = Proposed remediation goal was set at background
mg/kg = milligrams per kilogram
ng/kg = nanograms per kilogram
NA - not applicable
-- Indicates chemical is not a chemical of concern for that category
µg/kg = micrograms per kilogram

Table 2-2

Site 1A-1 Summary of Detailed Analysis of Alternatives
OU 5 FS, MCB Camp Pendleton, California

| NCP Criterion | Alternative 1A1-1 | Alternative 1A1-2 | Alternative 1A1-3 | Alternative 1A1-4 |
|---|---|---|---|---|
| | **No Action** | **Institutional Controls** | **Capping (Engineered Soil Cover), Cap Monitoring/ Maintenance, and Institutional Controls** | **Soil Excavation, Backfill, and Off-Base Land Disposal** |
| **Overall Protection of Human Health and the Environment** | | | | |
| Human Health Protection | Provides no reduction in baseline risks. Existing soil contamination will remain. Not protective of human health. | Existing soil contamination will remain. Eliminates potential exposure by controlling site use. Protective of human health. | Existing soil contamination will remain. Effectively reduces availability of contaminated soil to receptors and eliminates exposure pathways. Protective of human health. | Reduces risks by excavating and removing all contaminated soil exceeding RGs, and disposing of it in an off-Base licensed disposal facility. Site would be backfilled with clean imported soil. Protective of human health. |
| Environmental Protection | Soil contamination poses a risk to local habitats and potential ecological receptors. Existing soil contamination could pose a threat to groundwater. Not protective of the environment. | Soil contamination poses a risk to local habitats and potential ecological receptors. Existing soil contamination could pose a threat to groundwater. Not protective of the environment | Reduces risks by preventing contact with contaminated soil and reducing groundwater infiltration. Protective of the environment. | Reduces risks by excavating and removing all contaminated soil exceeding ecological risk and groundwater impact levels. Site would be backfilled with clean imported soil. Protective of the environment. |
| **Compliance with ARARs** | | | | |
| Chemical-Specific ARARs | Does not comply with ecological ARARs. | Complies with risk-based and ecological ARARs. | Complies with risk-based and ecological ARARs. | Complies with risk-based and ecological ARARs. |
| Location-Specific ARARs | Would not comply with location-specific requirements of the Endangered Species Act and RCRA requirements for sites located within a floodplain. | Would not comply with location-specific requirements of the Endangered Species Act and RCRA requirements for sites located within a floodplain. | On-site construction would comply with action- and location-specific requirements of the Endangered Species Act and the Migratory Birds Act. Coordination with the USFWS would be required. | On-site excavation would comply with action- and location-specific requirements of the Endangered Species Act and the Migratory Birds Act. Coordination with the USFWS would be required. |

Table 2-2

**Site 1A-1 Summary of Detailed Analysis of Alternatives**
**OU 5 FS, MCB Camp Pendleton, California**

| NCP Criterion | Alternative 1A1-1 | Alternative 1A1-2 | Alternative 1A1-3 | Alternative 1A1-4 |
|---|---|---|---|---|
| | **No Action** | **Institutional Controls** | **Capping (Engineered Soil Cover), Cap Monitoring/ Maintenance, and Institutional Controls** | **Soil Excavation, Backfill, and Off-Base Land Disposal** |
| **Compliance with ARARs (continued)** | | | | |
| Action-Specific ARARs | No action-specific ARARs are identified for the no action alternative because no action is taken. | Partially meets this requirement by providing use restrictions and site monitoring/maintenance for surface soil erosion. | On-site construction would meet APCD emission ARARs. Complies with RCRA closure and post-closure requirements. | On-site excavation and transportation would meet RCRA ARARs and APCD emission ARARs. Complies with RCRA clean closure with no post-closure requirements. |
| **Long-Term Effectiveness and Permanence** | | | | |
| Effectiveness to reduce risk | Existing risk will remain because the contamination will not be removed. Would not provide long-term effectiveness and permanence. | Would reduce risk by eliminating potential exposure to soil contaminants. Provides long-term effectiveness for human health protection as long as institutional controls are enforced. Provides minimal long-term effectiveness for ecological risk protection. | Would reduce risk by eliminating potential exposure to soil contaminants. Provides long-term effectiveness and permanence through engineered cover. Long-term effectiveness depends on proper monitoring and maintenance of soil cover and enforcement of institutional controls. | Would reduce risk by excavating and removing all contaminated soil above action levels. Provides long-term effectiveness and permanence. |
| Adequacy and Reliability of Controls | Provides no reliable or adequate controls for remaining contamination. | Institutional controls would adequately and reliably reduce human health exposure pathways and risks. Not protective of ecological receptors or groundwater. | Soil cover and institutional actions would adequately and reliably reduce human health, ecological, and groundwater exposure pathways and risks. | Excavation and off-base disposal will adequately, reliably, and permanently reduce human health, ecological, and groundwater exposure pathways and risks. |
| Need for 5-Year Review | No review will be done. | A 5-year review will be conducted. | A 5-year review will be conducted. | No review will be conducted. |
| **Reduction of Toxicity, Mobility, or Volume Through Treatment** | | | | |
| Treatment Process Used | None. | None. | None. | On-base chemical fixation/ solidification (TTU). |
| Amount Destroyed or Treated | None. | None. | None. | Approximately 20,000 cubic yards of (in-place) contaminated soil. |

Table 2-2

Site 1A-1 Summary of Detailed Analysis of Alternatives
OU 5 FS, MCB Camp Pendleton, California

| NCP Criterion | Alternative 1A1-1 | Alternative 1A1-2 | Alternative 1A1-3 | Alternative 1A1-4 |
|---|---|---|---|---|
| | **No Action** | **Institutional Controls** | **Capping (Engineered Soil Cover), Cap Monitoring/ Maintenance, and Institutional Controls** | **Soil Excavation, Backfill, and Off-Base Land Disposal** |
| **Reduction of Toxicity, Mobility, or Volume Through Treatment (continued)** | | | | |
| Reduction of Toxicity, Mobility, or Volume | None. | None. | None. | Reduction of mobility but increase in volume through stabilization. |
| Irreversible Treatment | None. | None. | None. | Long-term irreversibility of stabilization is not well documented. |
| Type and Quantity of Residuals Remaining After Treatment | No treatment. | No treatment. | No treatment. | Contaminant concentrations remaining in the soil at the site would be at or below acceptable levels (i.e., remedial goals). |
| Statutory Preference for Treatment | Does not satisfy the statutory preference for treatment. | Does not satisfy the statutory preference for treatment. | Does not satisfy the statutory preference for treatment. | Partially satisfied because the soil will be treated off base before disposal. |
| **Short-Term Effectiveness** | | | | |
| Community Protection | Risk to community will remain the same as the baseline risk. RME risk to a hypothetical nonintrusive worker ($2 \times 10^{-4}$) is at the upper end of the USEPA risk management range; the site is considered to be protective of human health. | No risk to community from planned institutional controls. | Temporary increase in potential risks due to dust emissions from soil handling, moving, and stockpiling during soil cover construction. | Temporary increase in potential risks due to dust emissions from soil handling, transportation, and treatment at off-base facility. |
| Worker Protection | Not applicable because no remedial action will be implemented. | Limited protection would be required during site erosion control maintenance activities. | Protection would be required against potential inhalation of fugitive dust, dermal contact, and ingestion of impacted soil during site construction (use of PPE and dust suppressants). | Protection would be required against potential inhalation of fugitive dust, dermal contact, and ingestion of impacted soil site soil during excavation, transportation, and off-site disposal (use of PPE and dust suppressants). |

Table 2-2

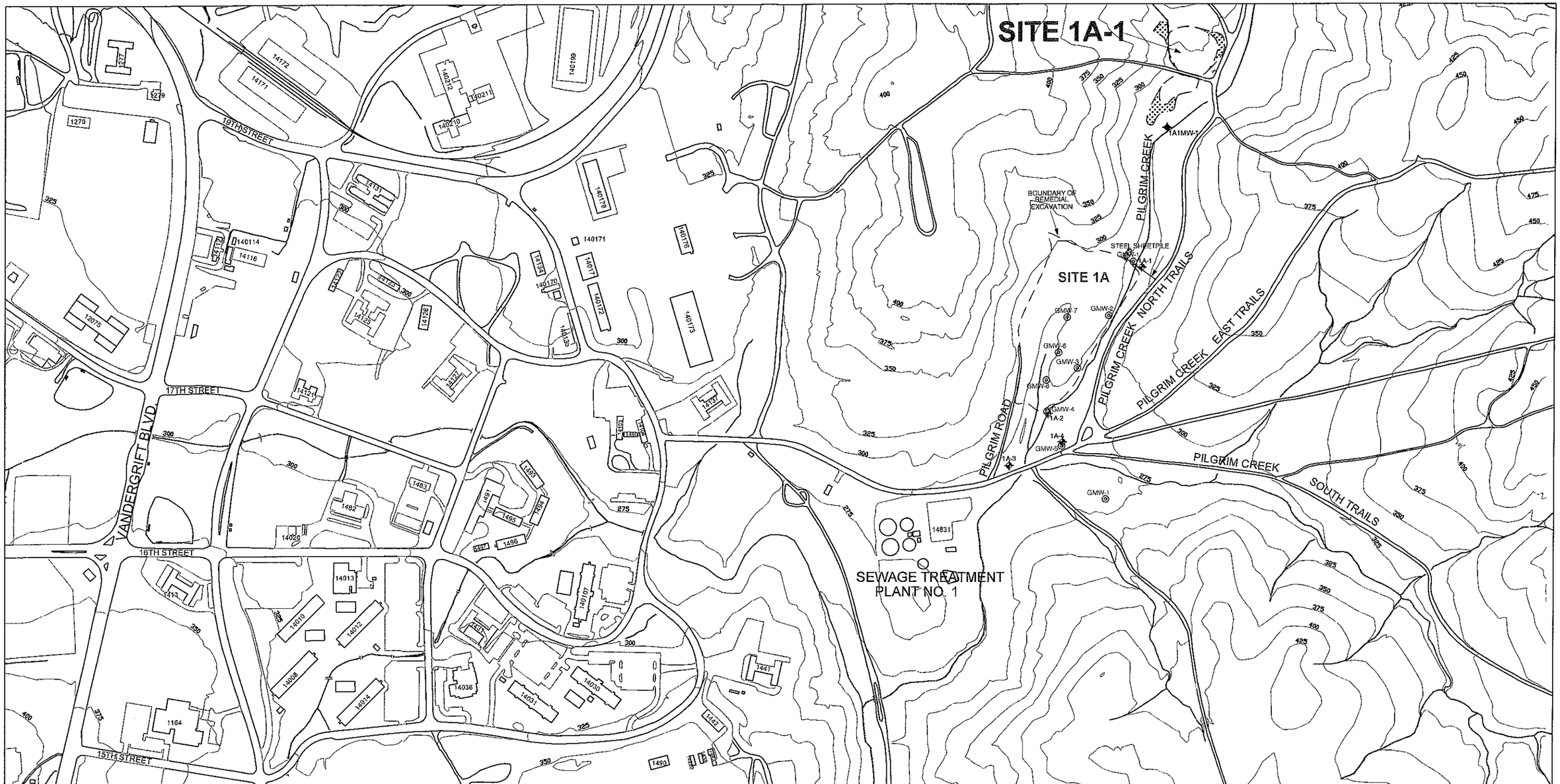
Site 1A-1 Summary of Detailed Analysis of Alternatives
OU 5 FS, MCB Camp Pendleton, California

| NCP Criterion | Alternative 1A1-1 | Alternative 1A1-2 | Alternative 1A1-3 | Alternative 1A1-4 |
|---|---|---|---|---|
| | **No Action** | **Institutional Controls** | **Capping (Engineered Soil Cover), Cap Monitoring/ Maintenance, and Institutional Controls** | **Soil Excavation, Backfill, and Off-Base Land Disposal** |
| **Short-Term Effectiveness (continued)** | | | | |
| Environmental Impacts | No impact from existing conditions. | No adverse environmental impact from institutional controls. | No significant adverse impacts to environment. Some short-term impacts to ecological receptors and habitats could occur. Affected area would be revegetated following completion of remedial actions. Close coordination with the appropriate regulatory agencies would be required. | No significant adverse impacts to environment. Some short-term impacts to ecological receptors and habitats could occur. Affected area would be revegetated following completion of remedial actions. Close coordination with the appropriate regulatory agencies would be required. |
| Time Until Action Is Completed | Not applicable. | Continued site maintenance | < 2 years (including permitting). | 26 weeks. |
| **Implementability** | | | | |
| Ability to Construct and Operate | No construction or operation is involved. | Land use restrictions and site maintenance are readily implementable. | Construction and maintenance of engineered soil cover are readily implementable. Portions of the waste within the floodplain could be moved to higher ground. Uses standard and readily available labor skills, equipment, and materials. | Excavation, stabilization, and disposal are readily implementable. |
| Ease of Doing More Action if Needed | Because no action is involved, there will be no interference with future actions. | Soil remedial actions can easily be implemented, if required in the future. | Soil remedial actions can be easily implemented, if required in the future. | Soil remedial actions can easily be implemented, if required in the future. |
| Ability to Monitor Effectiveness | Not applicable because no remedial action will be implemented. | Site will be periodically monitored for erosion control. Land use control measures will be enforced. | Effectiveness will be monitored through periodic O&M to preserve or restore the physical integrity and functionality of the cover. Land use control measures will be enforced. | Effectiveness will be monitored through confirmation sampling and analysis during excavation. |

Table 2-2

**Site 1A-1 Summary of Detailed Analysis of Alternatives**
**OU 5 FS, MCB Camp Pendleton, California**

| NCP Criterion | Alternative 1A1-1 | Alternative 1A1-2 | Alternative 1A1-3 | Alternative 1A1-4 |
|---|---|---|---|---|
| | **No Action** | **Institutional Controls** | **Capping (Engineered Soil Cover), Cap Monitoring/ Maintenance, and Institutional Controls** | **Soil Excavation, Backfill, and Off-Base Land Disposal** |
| **Implementability (continued)** | | | | |
| Ability to Obtain Approvals and Coordinate with Other Agencies | No approval is necessary. | No approval is necessary. | Would require coordination with and approval from USFWS to ensure protection of ecological receptors during soil cover construction activities. | Manifests will be required for transportation of wastes. Off-base facility has existing permits for treatment and disposal. Would require coordination with and approval from USFWS to ensure protection of ecological receptors during excavation activities. |
| Availability of Services and Capacities | Not applicable. | Services are available for the proposed institutional controls. | Services are commercially available for the construction and maintenance of the soil cover. | Services are commercially available for the excavation/earthwork and off-base disposal. |
| Availability of Equipment, Specialists, and Materials | Not applicable. | All services require commercially available standard equipment and machinery. | All services require commercially available standard equipment and machinery. | All services require commercially available standard equipment and machinery. |
| Availability of Technologies | Not applicable. | All technologies are proven and available. | All technologies are proven and available. | All technologies are proven and available. |
| **Cost** | | | | |
| Overall Cost | $0 | $295,000 | $2,575,000 | $8,062,600 |




## Legend

- Boundary of Site 1A-1 Waste Fill Soil (Based on Surface Mapping and Boring Logs)
- Surface Debris (Based on Surface Mapping and Boring Logs)
- Site 1A-1 Groundwater Monitoring Well Location
- Site 1A Groundwater Monitoring Well Location
- Site 1A Piezometer Location

N

0 500 1000

Scale in Feet

**Figure 2-1**

**Site 1A-1**
**Site Location Map**

MCB Camp Pendleton, California

**PARSONS**

Pasadena, CA

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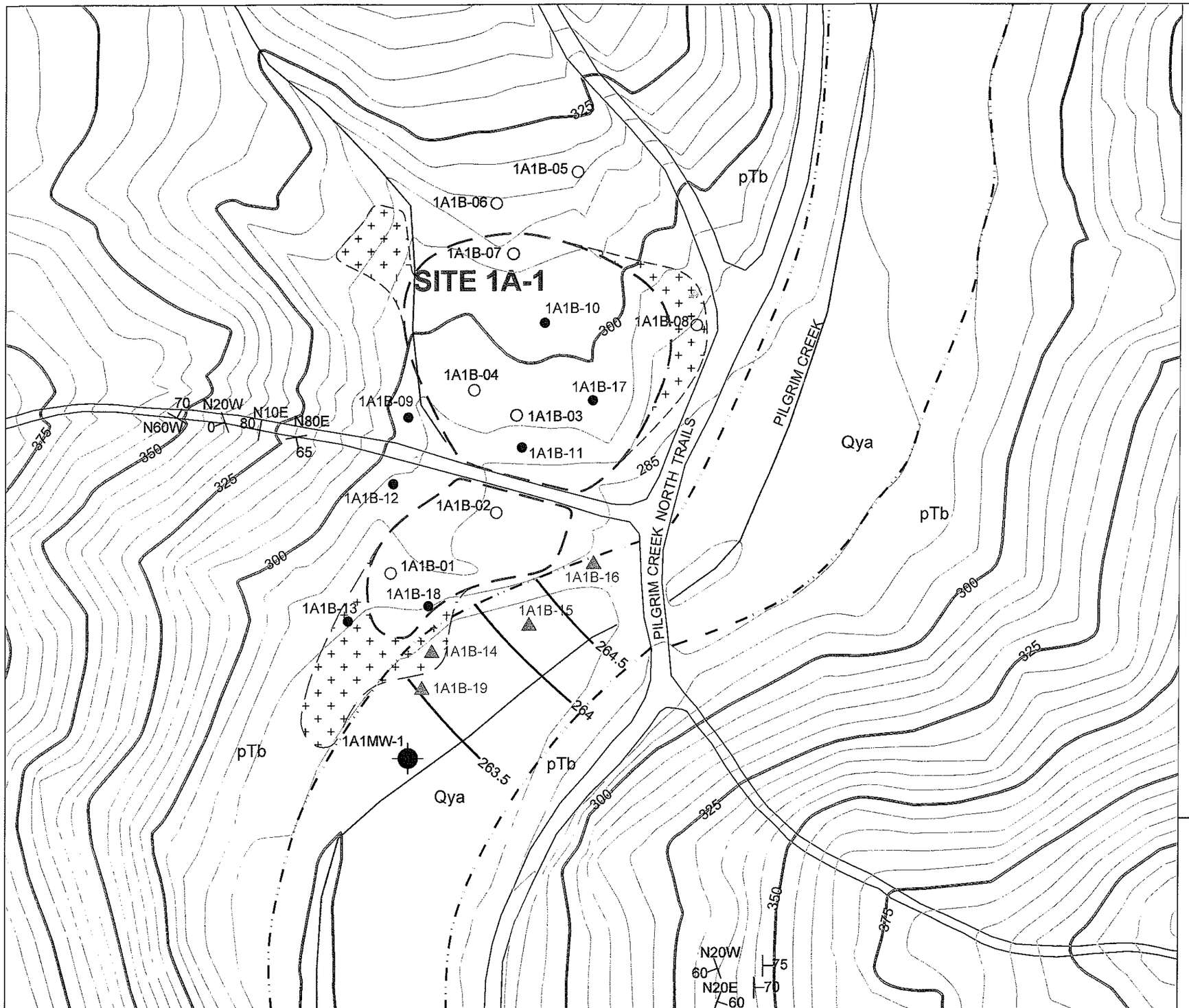


## Legend

- Boundary of Waste Fill Soil (Based on Surface Mapping and Boring Logs)
- Surface Debris (Based on Surface Mapping and Boring Logs)
- 264 — Approximate Groundwater Elevation Isocontour (Based on Boring Logs; January 2003)
- Soil Boring Location (2001)
- Soil Boring Location (2003)
- Soil Boring Located in Streambed Sediments (2003)
- Groundwater Monitoring Well Location

**Geology**

- Approximate Geologic Contact
- Qya — Younger Alluvium (Gravel, Sands, Silts, and Clays)
- pTb — Pre-tertiary Basement Complex (Igneous and Metamorphic Rocks)
- N80E / 65 — Strike and Dip of Bedrock Fractures

N

0 100 200

Scale in Feet

**Figure 2-2**

**Site 1A-1**
**Soil Boring and Groundwater Monitoring Well Locations**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

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| Soil General Response Actions | Remedial Technology | Process Options | Description | Screening Comments |
|---|---|---|---|---|
| No Action | None | None | No action is taken. | Required for consideration by NCP. |
| Institutional Control | Access Restrictions | Use Restrictions/Fencing | Administrative/physical measures are taken to limit site access and use and secure the site. | Potentially applicable. Only partially effective for ecological receptors. |
| Containment | Capping | Asphalt Cap | Single-layer bituminous asphalt surface cover is placed over site. | Not applicable due to site conditions. |
| | | Concrete Cap | Single-layer concrete cover composed of aggregate and cementitious mixtures is placed over site. | Not applicable due to site conditions. |
| | | Flexible Membrane Liner | Flexible membrane liner covered with clean soil and vegetation. | Not applicable due to site conditions. |
| | | Engineered Soil Cover | Single- or multi-layered soil cover designed to required performance standards. | Potentially applicable. |
| Removal | Excavation | Mechanical Excavation | Contaminated soil is excavated using heavy equipment. | Potentially applicable. |
| Disposal | Land Disposal | Backfilling | Treated soil is used as a backfill for the excavated site area. | Not applicable due to site conditions. |
| | | On-Base Landfilling | Contaminated soil is transported to an on-Base landfill. | Not applicable. No on-Base landfill available. |
| | | Off-Base Landfilling | Contaminated soil is transported to a permitted off-Base disposal facility. | Potentially applicable. |

Process Option Screened Out During Initial Screening

**Figure 2-3**

**Site 1A-1**
**Initial Screening of Technologies for Soil**
**(Page 1 of 2)**

MCB Camp Pendleton, California

**PARSONS**

Pasadena, California

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| Soil General Response Actions | Remedial Technology | Process Options | Description | Screening Comments |
|---|---|---|---|---|
| In Situ Treatment | Physical/Chemical | Soil Flushing | Flushes contaminants out of soil via injection or infiltration of water or aqueous solution. Groundwater collection and treatment required. | Not readily implementable. Degrades groundwater where it is not currently a concern. |
| | | Solidification/Stabilization | Chemical reagents are mechanically mixed with soil matrix to reduce the toxicity and mobility of metals. | Not effective for site conditions. |
| | | In Situ Vitrification | Soil waste is heated to the melting point through electrically-charged probes; glassy monolith results. | Difficult to implement and impractical for site conditions. |
| | Biological | Phytoremediation | Plants are used to extract contaminants from shallow soils. | Not effective for metals and depth of contamination. |
| Ex Situ Treatment | Physical/Chemical | Soil Washing | Water-based waste removal process. Water can be augmented with surfactant, leaching agent, or chelating agent. | Not effective for site conditions. |
| | | Acid Extraction | Metals are solubilized and removed from the soil using acidic reagents (i.e. hydrochloric acid). | Not very effective for metals and difficult to implement. |
| | | Solidification/Stabilization | Chemical reagents are mixed with excavated soil to reduce the toxicity and mobility of metals. | Not effective for site conditions (i.e. abundant anthropogenic debris in impacted soils). |
| | | Vitrification | Excavated soil is heated to the melting point through electrical power to form stable glass and crystalline structure. | Difficult to implement and impractical for site conditions. |
| | Thermal | Thermal Desorption | Uses heat in a controlled environment to desorb and remove contaminants from the soil. | Not effective for metals. |
| | | Incineration | Contaminated soil is burned in a controlled environment to remove organic contaminants. | Not effective for metals. |

Process Option Screened Out During Initial Screening

**Figure 2-3**

**Site 1A-1**
**Initial Screening of Technologies for Soil**
**(Page 2 of 2)**

MCB Camp Pendleton, California

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| Soil General Response Actions | Remedial Technology | Process Options | Effectiveness Rating | Implementability Rating | Cost Rating |
|---|---|---|---|---|---|
| No Action | None | None | Low; contaminants would remain in the soil. Both human and ecological receptors could be exposed. RAOs are not achieved. | High; no action is needed. | High; there are no costs. |
| Institutional Control | Access Restrictions | Use Restrictions/Fencing | Moderate; contaminants would remain in the soil. Effective to reduce human exposure but not protective of ecological receptors. | Moderate; readily implementable. DON position is to limit the use of institutional controls to maximize the use of military training lands. | High; low capital and O&M costs. |
| Containment | Capping | Engineered Soil Cover | Moderate to high; covers contaminated soil. Effective to eliminate human and ecological exposure. Does not involve treatment; therefore does not reduce contaminant toxicity, mobility, or volume. | Moderate; readily implementable, portions of the waste within the floodplain may need to be moved to higher ground. DON position is to limit the use of institutional controls to maximize the use of military training lands. | Moderate; high capital costs, low O&M costs. |
| Removal | Excavation | Mechanical Excavation/ Backfilling | High; removes contaminated soil and backfills excavation with clean soil. Demonstrated ability to meet RAOs but without treatment; does not reduce contaminant toxicity, mobility, or volume. | Moderate to high; readily implementable. Requires agency approval, Base coordination, and H&S planning. | Moderate; high capital costs, low O&M costs. |
| Disposal | Land Disposal | Off-Base Landfilling | High; demonstrated ability to meet RAOs but without treatment; does not reduce contaminant toxicity, mobility, or volume. | High; readily implementable. Landfilling of hazardous waste viewed unfavorable; increasingly difficult and expensive option. | Moderate; high capital costs, low O&M costs. |

Figure 2-4

Site 1A-1
Evaluation of Process Options
for Soil

MCB Camp Pendleton, California

PARSONS

Pasadena, California

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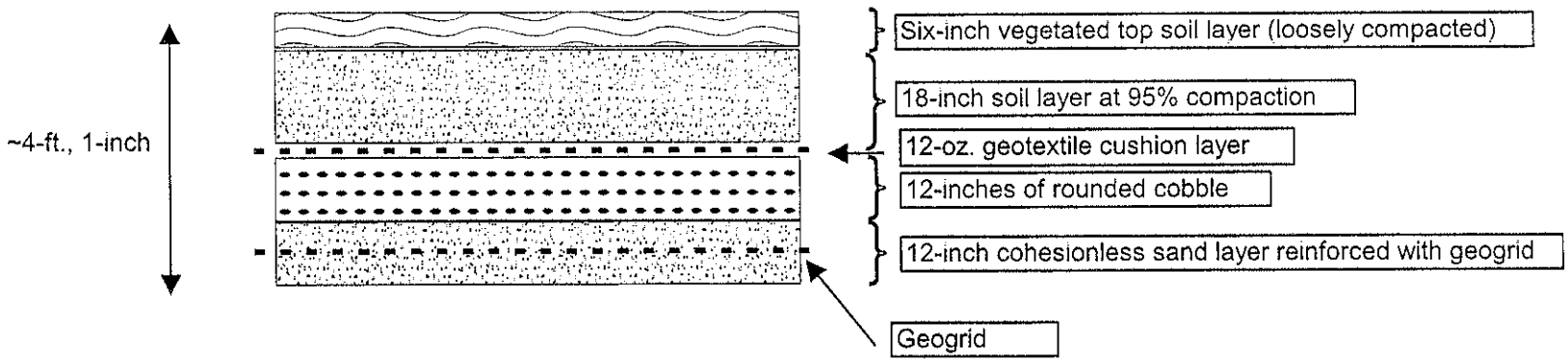


**Figure 2-5**

**Site 1A-1**
**Generalized Cross Section of Evapotranspiration Cover**

MCB Camp Pendleton, CA
**PARSONS**
Pasadena, CA

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# 3.0 SITE 1111

Site 1111 is located in the 26 Area in the northeastern portion of MCB Camp Pendleton (Figure 3-1), approximately 8 miles northeast of the main gate and 1,600 feet northwest of Vandergrift Boulevard.

## 3.1 Background Information

Although this FS provides a summary of site conditions, it does not repeat all the information provided in previous documents regarding detailed site descriptions, histories, regional and site-specific environmental information, or results of previous investigations and risk assessments. This information is incorporated by reference as appropriate and is documented in the following reports:

- Remedial Investigation/Feasibility Study, RI Report for Group A Sites, Draft Final (SWDIV, 1993) (Site 3)
- Draft Remedial Investigation and Feasibility Study, OU 4 (Parsons, 1999a)
- Draft Final OU 5 RI Field Sampling Plan (Parsons, 2001)
- Draft Final OU 5 RI Field Sampling Plan Addendum (Parsons, 2003b)
- Draft Final Remedial Investigation Report for OU 5 Sites 1A-1, 6A, 21, 1111, and 12 Area (Site 13) (Parsons, 2004).

### 3.1.1 Site Description and History

Site 1111 is adjacent to the former Site 3 Pest Control Wash Rack, a Group A site documented in the Group A RI Report (SWDIV, 1993) (Figure 3-2). Site 3 was known as a pesticide wash rack, where equipment used in the application of pesticides and herbicides was rinsed from the 1950s to the 1980s.

Soil excavation, treatment, and disposal were conducted at Site 3 from May 1996 to January 1997. During remedial activities at Site 3, a subsurface layer of ash and burn material was exposed in the northeastern portion of Subsite 3D (OHM, 1997a). Excavation continued to the sensitive habitat boundary and down to groundwater, 5 to 6 feet bgs. However, the concentrations of the COCs in remaining waste material exceeded remediation goals. The remaining burn layer has been designated as Site 1111 and was included as an IR site in 1997 (USEPA, 1997).

Elevated levels of numerous organic and inorganic contaminants have been detected in Site 1111 soils. The results of the previous risk assessments indicate a potential threat to human and ecological receptors. Presence of a burn layer extending down to the groundwater table likely poses a threat to groundwater. Various organic and inorganic compounds are present in site groundwater above tap water PRGs and MCLs. The site is in an ecologically sensitive area suitable for use by the least Bell's vireo, which are endangered under both the state and federal Endangered Species Acts, and the southwestern arroyo toad, which are endangered under federal Endangered Species Act and considered a California species of concern.

Site 1111 is not currently used for any military or civilian activity. The site contains sensitive ecological habitat. Future land use plans indicate that use of this site will likely remain the same. The likelihood of future residential use is considered low given current

development plans, current land use in the vicinity of the site, the presence of sensitive ecological habitat, and the presence of the site within the flood plain of the Santa Margarita River. The nearest family housing is at the Ranch House located about 1 mile southeast of the site and in the De Luz Area, approximately 1.5 miles northeast of the site. The nearest downgradient in-service Base production well, 10S/04W-07R02, is located 1,850 feet southwest of the site (Figure 3-1). Site 1111 is within the capture zone of this well (SWDIV, 1993). An upgradient groundwater production well, 10S/04W-07H02, is located 1,300 feet north of the site. Both wells are in service. Current analytical results and fate-and-transport analysis indicate that site contamination has not migrated, and is not projected to migrate, to the Base production wells.

### 3.1.2 Site Conditions

This section includes a brief description of site topography, surface water, geology, hydrogeology, and ecology, which are described in more detail in the OU 5 RI (Parsons, 2004).

#### 3.1.2.1 Topography

The topography at Site 1111 generally slopes gently toward the southwest parallel to the Santa Margarita River channel, although locally there are various knolls and small hills across the site consisting of alluvial deposits, which are elevated above the general site topography. The knolls impart a hummocky topographic expression to the area. In addition, the low-lying areas around the small hills act as channels that can accumulate standing water during wet weather or significant flow in the river channel. The site elevation is approximately 100 feet amsl, with the knolls rising 5 to 10 feet above the general site topography.

#### 3.1.2.2 Surface Water

Site 1111 is located immediately east of, and adjacent to, a southwest-flowing drainage within the Santa Margarita River basin, approximately 2,300 feet east of the center of the Santa Margarita River. Surface water is intermittently present on or near the site, particularly during or after rainy weather. An intermittent stream is present approximately 100 feet northwest of the site, which may be a tributary to the Santa Margarita River (Figure 3-1). A drainage swale exists immediately north of the site that collects and diverts surface water runoff toward the northwest, to the southwest-flowing stream. Also, surface water periodically collects in a low-lying area southwest of the site. Surface water, when present, generally flows toward the west, to the southwest-flowing stream.

#### 3.1.2.3 Geology

Site 1111 is situated on the unconsolidated alluvium of the Santa Margarita River basin. Based on borings drilled to a maximum of 20 feet, shallow subsurface soils consist primarily of poorly graded (i.e., moderately well sorted) sand with trace amount of silt, which are interbedded in some areas with silty sand. Based on results of previous and current subsurface investigations, soil beneath Site 1111 consists of the following:

- Borings logs for 1111B01, 1111B02, and 1111B03, and 1111TP-1 and 1111TP-2 all show gravel backfill to depths of 4 to 5 feet bgs, although gravel was only encountered to a depth of 2 feet bgs in 1111B03. The limits of the gravel backfill encompass this area.

- An approximately 6-inch thick layer of burned wood and other debris was encountered below the gravel at a depth of approximately 5 feet in borings 1111TP-1 and 1111TP-2 and, similarly, there was black soil and evidence of burning in borings 1111B01 and 1111B02. The burn layer was underlain by silty sand. Boring 1111B03 showed trash and debris at this depth, but no evidence of burning. Boring 1111SB-04, indicated a possible burn layer at 5 feet bgs, but this boring is approximately 40 feet northeast of any other borings where burn material was encountered, and analytical results do not indicate the burn layer extends to this location (i.e., COCs are below USEPA Region 9 residential PRGs).
- In areas outside the gravel backfill and burn layer area, sand and silty sand were encountered in monitoring well locations from ground surface to a maximum depth of 22 feet bgs.

Based on the observations recorded in boring logs, soils are generally moist with saturated samples collected below a depth of 10 feet.

#### 3.1.2.4 Hydrogeology

Groundwater was encountered at a depth of approximately 4 to 9 feet below ground surface at Site 1111. Groundwater underlying the site is unconfined, and groundwater flow is generally toward the southwest at an average gradient of approximately 0.002 feet per foot (ft/ft). Corresponding groundwater elevations ranged from 91.46 to 92.25 feet amsl in March 2003. The site is located within the Upper Ysidora Hydrologic Subarea (2.13) of the Ysidora Hydrologic Area (2.10) of the Santa Margarita Hydrologic Unit (2.00) (RWQCB, 1994).

Slug tests were performed at monitoring wells 1111MW-01, 1111MW-02, and 1111MW-03 at Site 1111 in December 1998 (Parsons, 1999a). The maximum hydraulic conductivity value calculated for Site 1111 was 138 feet per day (ft/day) (0.049 centimeters per second [cm/sec]) at well 1111MW-02, which is screened in a medium to coarse-grained sand with some fines present. The minimum value calculated was 0.037 ft/day ($1.3 \times 10^{-5}$ cm/sec) in well 1111MW-01, which is screened in fine to medium grained sand. The average of all the values calculated from these slug tests was 51 ft/day (0.018 cm/sec). Note that slug test data typically reflect localized conditions within the immediate vicinity of wells, rather than the more steady-state conditions created by continuous purging.

The nearest downgradient in-service Base production well, 10S/04W-07R02, is located 1,850 feet southwest of the site (Figure 3-1). Site 1111 is within the capture zone of this well (SWDIV, 1993). An upgradient groundwater production well, 10S/04W-07H02, is located 1,300 feet north of the site.

#### 3.1.2.5 Ecology

The proximity of Site 1111 to the Santa Margarita River is ecologically significant because the area supports diverse wildlife and plant species. Approximately 10 to 20 mammal species and 80 resident and migratory bird species may regularly use the site vicinity. About 8 to 10 species of amphibian and reptiles probably occur in the site vicinity, including western toad and common king snake. The adjacent riparian habitats of the Santa Margarita River support numerous endangered and threatened wildlife species, including the arroyo southwestern toad, Pacific pocket mouse, southwestern pond turtle, least Bell's vireo, and southwestern willow flycatcher (SWDIV, 1993).

The undisturbed/unremediated portion of Site 1111 is considered arroyo southwestern toad habitat, and therefore is a sensitive ecological habitat. Least Bell's vireos and southwestern willow flycatchers are also known to nest at Site 1111. Vegetation has been removed in the disturbed/remediated portion of Site 1111.

### 3.1.3 Nature and Extent of Contamination

As discussed in the OU 5 RI (Parsons, 2004), a soil removal action was performed adjacent to this site in 1997. The material presented in this section characterizes the residual levels of contaminants currently remaining on site. Based on site history, COPCs at Site 1111 include metals and various organic compounds such as pesticides, chlorinated herbicides, fuels, solvents, and by-products associated with the combustion of these materials (e.g., PAHs and dioxins/furans).

#### 3.1.3.1 Soil

Based on the OU 5 RI (Parsons, 2004), the COPCs in soil at Site 1111 include VOCs, SVOCs, dioxins/furans, organochlorine pesticides, chlorinated herbicides, and metals (primarily arsenic and lead). Figures 5-7 to 5-11 in Appendix B2 summarize detectable contaminant concentrations in site soil samples.

The highest concentrations of COPCs were detected within the burn layer. Based on the historical photographs, visual inspections, and soil sampling conducted at Site 1111, the volume of "hot spot" contaminated soils (i.e., soils that have visual evidence of contamination, contaminant concentrations above industrial PRGs, and likely will regulate remedial action) is approximately 1,100 cubic yards. This volume was calculated by multiplying the approximate aerial extent of the burn/ash layer and adjacent contaminated soil above background and/or industrial PRGs of 0.12 acre times the average depth of contamination estimated at about 6 feet. The estimate of six feet is based on the risk to human health or ecological receptors and that the groundwater table is present at approximately six feet. With regard to risk to groundwater, dioxins are highly immobile, there are no reported concentrations of dioxins in groundwater downgradient of the site, and the concentrations of dioxins reported below the water table are relatively low. Based on the uncertainty of specific dimensions of depth and extent, this estimate is considered to be within 25 percent of actual volume.

#### 3.1.3.2 Groundwater

Several VOCs, primarily chlorinated ethenes (PCE, TCE, *cis*-1,2-dichloroethene [DCE]) and ethanes, and BTEX compounds (benzene), have been detected in groundwater at concentrations above MCLs at Site 1111. The highest concentrations are observed in proximity to the known area of the burn layer, which also has the highest detections of COCs in soil. BTEX compounds were not detected in groundwater prior to the 2002 event, and were not detected in the wells resampled in 2003. BTEX levels in groundwater were reported in the 2001-2002 sampling event (Parsons, 2004).

### 3.1.4 Contaminant Fate and Transport

Contaminant fate and transport is discussed in detail in the OU 5 RI (Parsons, 2004). This section provides a brief summary of the conditions specific to Site 1111 and the results of the supplemental evaluation included in Appendix C to establish soil RGs that are protective of groundwater.

VLEACH evaluations during the OU 5 RI of indicator parameters 1,3,5-trimethylbenzene (TMB) and naphthalene, the two COPCs with the highest soil concentrations and designated level methodology (DLM) ratios, indicate that maximum concentrations in soil water (leachate) at the groundwater table interface would exceed MCLs for about 40 to 75 years. Overall, the DLM and VLEACH modeling results indicate that vadose zone contaminants in the source area at Site 1111 pose a continuous threat to groundwater. However, VOCs are the only organic compounds detected in groundwater above MCLs. VOCs, with their relative high solubilities and low adsorptive tendencies, are the most mobile COCs at Site 1111.

Supplemental VLEACH/SUMMERS evaluations were conducted in this FS to determine soil RGs for all 17 organic compounds (seven VOCs, seven SVOCs, and three pesticides) that failed DLM at Site 1111 in the OU 5 RI These evaluations are presented in Appendix C. The results are summarized in Table C-27. Nine of the 17 organic contaminants evaluated are present in the waste soil at concentrations that exceed their maximum allowed leachate concentrations. These contaminants pose a direct threat to groundwater underlying Site 1111 under the current conditions. The average soil RGs for groundwater protection for all 17 contaminants evaluated are presented in Table C-27. The maximum soil concentrations of all nine contaminants exceed their average soil RGs.

The estimates of the time required to dissolve and lower contaminant concentrations in the source area to levels below established RGs is a function of the VOC mass present in the vadose and saturated zones. Based on a source area of approximately 60 ft. x 20 ft, an average vadose zone depth of 6 ft., a saturated thickness of 25 ft., and a soil porosity of 0.3, a total of 171 lbs. (78 kg.) of VOCs were calculated to exist in the vadose zone, versus a total 1.5 lbs (0.55 kg) of VOCs in the saturated zone (i.e., soil and groundwater). Roughly 99 percent of the total VOC mass is present in the vadose zone and only 1 percent is present in the saturated zone. These estimates are highly conservative since the maximum concentration of each VOC was used in the calculations. The VOC mass calculations for Site 1111 are presented in Appendix C. Note that the estimated total CAH mass, 6 lbs., is only about 4 percent of the total VOC mass; yet CAHs comprise 84 percent of the 1.5 lbs of VOC mass present in the saturated soil and groundwater Thus, chlorinated compounds pose the greatest risk of impacting groundwater and migrating away from the source area.

Based on the predominance of chlorinated compounds (e.g., PCE and TCE) in groundwater samples, BIOCHLOR, a one-dimensional groundwater model, was used during the RI to evaluate the biodegradation and transport of the chlorinated ethenes plume in the aquifer. The source area (i.e., burn layer) was assumed to represent a continuous source of VOCs to groundwater. The BIOCHLOR evaluations indicated that the CAH plume is at a steady state, with PCE and TCE concentrations above MCLs reaching a maximum distance of 200 feet downgradient of the source, and the leading edge of the plume (i.e., above detectable levels, greater than 0.5 µg/L) extending to about 350 to 400 feet. The results of the model are presented in detail in the OU 5 RI Report (Parsons, 2004).

BIOCHLOR calculated a total mass of PCE and TCE in the dissolved plume of approximately 0.4 kg. This is consistent with the VOC mass calculations presented in Appendix C. The model estimates that about 98 percent of the dissolved PCE and TCE mass is removed within 400 feet of the source, approximately 75 percent by biotransformation. If current conditions do not change (i.e. no soil removal action in the

source area), the burn layer would provide an on-going source of VOCs to groundwater, and the CAH plume would be expected to remain at a steady state for a long time.

The NAS was used to calculate the time of remediation by natural attenuation processes for the chlorinated compounds at Site 1111. NAS is designed to determine the rate at which natural degradation processes (dispersion, advection, sorption, and biodegradation) remove contaminants in groundwater systems (USGS, 2003). NAS was used to evaluate the effects of source reduction on the overall remediation times. Assuming that soil Alternative 1111-S3 is implemented, all VOC mass in the vadose zone (78 kg.) would be excavated, representing 99 percent of the total estimated VOC mass in the subsurface. The NAS calculations indicate that the time of remediation for the remaining 0.55 kg of VOC mass to dissolve and lower concentrations to below RGs after source removal would be approximately 3.4 years to achieve MCLs in groundwater, and 4.9 years to achieve background concentrations.

### 3.1.5 Human Health Risk Assessment

This section provides a brief summary of the Human Health Risk Assessment (HHRA) discussed in detail in the OU 5 RI (Parsons, 2004). The cumulative RME risk to a nonintrusive worker was estimated to be $1 \times 10^{-5}$, with the risk attributable to dioxins/furans, hexachlorobenzene, and arsenic. The corresponding RME risk to an intrusive worker was $6 \times 10^{-6}$. The maximum route-specific hazard index for both the RME nonintrusive worker and the RME intrusive worker were estimated to be less than the USEPA's target HI of one.

The 95-percent UCL surface (0 to 1.5 feet bgs) and mixed (0 to 10 feet bgs) soil exposure point concentrations of 110 and 380 mg/kg, respectively, are within the USEPA Adult Lead Model default industrial soil PRG range of 780 to 1,200 mg/kg based on USEPA's re-analysis (2002c) and reported in the finalized Adult Lead Model technical guidance (USEPA, 2003). USEPA Region 9 conservatively used the lower end of this range when selecting an industrial soil screening PRG of 800 mg/kg (2004b). Therefore, the lead 95-percent UCL in the mixed soil interval was 380 mg/kg, with concentrations ranging from 0.7 to 19,000 mg/kg.

Although it is extremely unlikely that a water production well would ever be constructed and screened in the shallow groundwater at Site 1111, the RME risk to a hypothetical adult domestic water user, based on default exposure assumptions and USEPA toxicity factors, was estimated to be $2 \times 10^{-3}$. Primary contributors included arsenic ($9 \times 10^{-4}$), TCE ($3 \times 10^{-4}$), and 2,6-dinitrotoluene ($2 \times 10^{-4}$). The maximum route-specific adult hazard index was estimated to be 18, with TCE (hazard quotient [HQ] = 5), antimony (HQ = 4), arsenic (HQ = 5), and thallium (HQ = 2) the primary contributors. The maximum child hazard index was 43. These estimates, which are based on maximum detected groundwater concentrations, exceed the upper end of the USEPA risk range and target hazard index of one.

### 3.1.6 Ecological Risk Assessment

This section provides a brief summary of the Ecological Risk Assessment (ERA) discussed in detail in the OU 5 RI (Parsons, 2004). The ERA evaluated available data on the presence of COPCs, defined as any chemical detected in soil samples collected from Site 1111. At Site 1111, COPCs, including inorganics, PAHs, polychlorinated dibenzo-*p*-dioxins and dioxins, pesticides, SVOCs, and VOCs, entered the quantitative ERA process. Concentrations of COPCs in soil were utilized to estimate exposures to a

variety of potential ecological receptors: plants, terrestrial invertebrates, mammals, and birds. In Tier 1, estimated exposures were evaluated against SEVs, defined as protective (conservative) concentrations of chemicals that are not associated with adverse ecological effects, while in Tier 2, further refinements were made to the exposure estimates and additional ecotoxicity concentrations were utilized, based on adverse-effect-inducing concentrations.

Based on exceeding SEVs in Tier 1, the site does not qualify for a no further action decision. A total of 64 COPCs (17 inorganics, 13 PAHs, dioxins, 10 pesticides, 6 SVOCs, and 18 VOCs) were carried through to the Tier-2 BERA. Based on the refined analysis conducted in the Tier-2 assessment, 10 COPCs are present at concentrations that are predicted to pose a potentially significant hazard to one or more ecological receptors:

- inorganics: antimony and mercury;
- dioxins; and
- semivolatile organic compounds: hexachlorobenzene.

In accordance with guidance-directed conclusion options from a Tier-2 BERA, these COPCs require additional consideration for remedy development in a Tier-3 assessment.

### 3.1.7 RI Conclusions

Based on the data collected to date and the analyses documented in this report, the following RI conclusions were reached regarding Site 1111:

- The total volume of soil that has been impacted by contaminants that pose a threat to human health and the environment is estimated to be approximately 1,100 cubic yards. This is based on surface and subsurface data collection and analytical testing to define the lateral and vertical extent of contamination.
- Groundwater has been impacted by contaminants exceeding MCLs, including PCE and TCE. Benzene was not detected during the 2003 sampling event. The highest contaminant concentrations in groundwater are observed in proximity to the known burn debris area, which also has the highest detections of COCs in soil.
- Nine vadose zone contaminants in the source area at Site 1111 exceed their maximum allowed leachate concentrations and pose a continuous threat to groundwater. Based on fate-and-transport modeling, VOCs in groundwater have reached a steady state condition with concentrations above MCLs reaching a maximum distance of 200 feet, and detectable concentrations reaching a maximum distance of 400 feet from the source area. Biodegradation plays an important role in plume stability.
- Chlorinated compounds pose the greatest risk of migrating away from the source area. The nearest downgradient in-service Base production well, 10S/04W-07R02, is located 1,850 feet southwest of the site. Site 1111 is within the capture zone of this well (SWDIV, 1993).
- The site does not currently pose a threat to human health because there are no receptors. However, there would be a potential adverse risk under hypothetical future use of the site.

- The cumulative RME risk to a nonintrusive worker was estimated to be $1 \times 10^{-5}$. The corresponding RME risk to an intrusive worker was $6 \times 10^{-6}$. The maximum route-specific hazard index for both the RME nonintrusive worker and the RME intrusive worker were estimated to be less than the USEPA's target HI of one.
- Lead concentrations at Site 1111 ranged up to 19,000 mg/kg. The 95 percent UCL mixed (0 to 10 feet bgs) and surface (0 to 1.5 feet bgs) soil exposure point concentration of 96 and 380 mg/kg, respectively, are within the default USEPA (1996b) industrial soil PRG range of 780 to 1,200 mg/kg.
- Although it is unlikely that a water production well would ever be constructed and screened in the shallow groundwater at Site 1111, the RME risk to a hypothetical adult domestic water user, based on default exposure assumptions and USEPA toxicity factors, was estimated to be $2 \times 10^{-3}$.
- The ecological risk assessment concluded that baseline conditions are not protective of ecological receptors at the site. Based on the site-specific tiered ecological risk assessment, four chemicals are present in soil at concentrations that are predicted to pose a potentially significant hazard to specific ecological receptors: antimony (birds and small mammals), mercury (herbivorous and omnivorous small mammals), dioxins (herbivorous and omnivorous small mammals), and hexachlorobenzene (omnivorous small mammals).

## 3.2 Development of Remedial Action Objectives for Soil

Both soil and groundwater are impacted media at Site 1111. This FS Report first addresses soil contamination (Sections 3.2 through 3.7), followed by groundwater contamination (Sections 3.8 through 3.13).

The purpose of this FS is to develop and evaluate remedial action alternatives for each of the OU 5 sites that comply with ARARs, are protective of human health and the environment, and can be implemented in a cost-effective manner.

As discussed in Section 1.4, in accordance with the framework of CERCLA, NCP, and SARA, the RI/FS and subsequent remedial activities conducted at Site 1111 must comply with federal and state ARARs. The ARARs/TBC that might apply to Site 1111 are discussed in detail in Appendix A. USEPA guidance (USEPA, 1988) requires that remedial action objectives (RAOs) be developed during the initial phase of the FS and be used as the framework for developing the remedial alternatives. Sections 3.2 through 3.7 address the soil contamination at Site 1111 that requires remediation based on the site characterization data collected to date

### 3.2.1 Chemicals of Concern in Soil

As determined in the ecological risk assessment presented in the OU 5 RI Report, antimony, mercury, hexachlorobenzene, and dioxins in soil pose a significant risk to ecological receptors at Site 1111. The human health risk assessment concluded that arsenic and dioxins contribute to a human health risk greater than $1 \times 10^{-6}$. A potentially significant threat to groundwater exists from VOCs in vadose zone soils in the source area at Site 1111.

The above compounds comprise the remedial COCs for Site 1111. RGs were established for these remedial COCs as outlined below in Section 3.2.3.

### 3.2.2 Exposure Routes/Receptors of Concern for Soil

Sections 3 1 5 and 3.1.6 summarize the exposure routes and receptors of concern.

### 3.2.3 Proposed Remedial Action Objectives and Remediation Goals for Soil

The RAOs for the Site 1111 soil contamination are defined below:

- Minimize exposure (inhalation/dermal contact/ingestion) to human and ecological receptors to chemicals in soil at concentrations that pose a potentially significant risk.
- Protect the beneficial uses and water quality objectives of the lower Santa Margarita River basin.

RGs were developed to meet these RAOs. The derivation of preliminary RGs that are protective of human health are presented in Appendix D. The site is currently not considered to be protective of human health for the receptors evaluated in the RI (intrusive and nonintrusive worker). The preliminary RG with the lowest concentration was selected from among the combined receptor preliminary RGs as the final RG for each remedial COC. The human health remedial COCs for Site 1111 are arsenic and dioxins based on the risk assessment in the RI Report (Parsons, 2004).

The derivation of preliminary RGs that are protective of ecological receptors is presented in Appendix E. In accordance with the US Navy guidance (1999e), the exposure and effects information used in the Tier-2 BERAs were used to develop a range of concentrations for ecological PRGs. The value selected, as a site- and chemical-specific ecological PRG, is the lowest of the ecological PRGs for any wildlife receptor, derived using an effect-based TRV. The ecological remedial COCs for Site 1111 are antimony, mercury, hexachlorobenzene, and dioxins based on the ecological risk assessment in the RI Report (Parsons, 2004).

The residual concentrations of all soil COPCs at Site 1111 were evaluated in the RI Report using DLM to identify contaminants present at concentrations that may pose a threat to groundwater. VLEACH/SUMMERS modeling was subsequently performed as part of this FS for all VOCs that failed DLM in the RI Report, for the purpose of deriving preliminary RGs that are protective of groundwater. This analysis is presented in Appendix C. The most stringent of the federal and California drinking water MCLs were selected as the water quality goals for each VOC. USEPA Region 9 tap water preliminary RGs were used in the absence of MCLs. The VLEACH/SUMMERS evaluations were used to establish soil cleanup goals for VOCs that would meet groundwater quality goals and are protective of the beneficial use of groundwater at the site.

A compilation of the preliminary RGs are shown on Table 3-1. In each case, the lowest value between the preliminary RGs, unless below background, was recommended as the RG.

In the event that soils are excavated from the site, confirmation sampling will be necessary as described in detail in Section 3.6.2.3.

RGs were also calculated for an unrestricted land use. An unrestricted land use would be achieved by meeting the standards of a residential exposure scenario. Note that a residential use of the site is not reasonably expected in the future, and therefore unrestricted land use is not a mandatory goal of cleanup for this site. However, the RGs that would achieve a residential exposure scenario are provided in this document

because it is likely that they would be met if waste soils were removed as outlined in the remedial alternatives. The RGs for unrestricted land use are incorporated into Appendix D for reference. If contaminated soils are ultimately removed, actual confirmation sample results can be compared to these RGs to determine if site cleanup meets the unrestricted land use standard.

## 3.3 Identification of General Response Actions for Soil

General response actions (GRAs) represent general classes of technologies that have common characteristics in the way they address the risk posed by contaminated soil (i.e., the RAOs). GRAs considered for Site 1111 include the following:

- No Action: No further remedial action for the contaminated soil.
- Institutional Control: Minimal activity that includes administrative and physical measures to restrict site access with no active remediation of the contaminated soil.
- Containment: Physical measures such as capping to restrict soil contaminant migration (e.g., wind erosion, surface runoff) or waste movement.
- Removal: Removal (i.e., mechanical excavation) of contaminated soil.
- Treatment (in situ and ex situ): Physical, chemical, and biological measures that would reduce toxicity, mobility, or volume of a contaminant or waste by altering the physical or chemical properties of the contaminants and/or media.
- Disposal: Placement of treated or untreated waste soil in a temporary or permanent, pre-engineered, controlled environment (i.e., landfill) that would restrict contaminant migration and eliminate exposure routes.

## 3.4 Identification and Screening of Technology Types and Process Options for Soil

The objective of this section is to identify remedial technologies and process options for application for soil remediation at Site 1111. This objective is accomplished using a variety of information including previous investigations, remedial actions at other sites, references developed by the USEPA for application at NPL sites, USEPA computerized technology databases (ATTIC, Version 1.0; VISIT Version 2.0; and CLU-IN), and standard engineering references.

For each GRA discussed above, one or more potentially applicable remedial technologies were identified. The goal of the screening process is to evaluate a large number of technologies to identify the ones that are potentially implementable for soil remediation and under the specific Site 1111 conditions. In this step, both process options and entire technology types can be eliminated based on technical effectiveness and/or implementability considerations. Information on site characteristics and contaminant types and concentrations was used to eliminate technology types and process options that are neither applicable nor effectively implementable at the site

The remedial technologies identified and evaluated in previous feasibility studies served as the starting point for the list of technology options evaluated in this FS report. These evaluations were revised as appropriate to reflect site conditions and technology updates. In addition, relevant new technologies were included in the evaluation. A summary of the technologies considered in this FS follows:

- Institutional Controls
  - Access Restrictions
  - Fencing
- Containment
  - Capping
- Removal
  - Excavation
- Disposal
  - Landfill
  - Backfilling
- In Situ Physical/Chemical Treatment
  - Soil Flushing
  - S/S
  - In Situ Vitrification
- In Situ Biological Treatment
  - Phytoremediation
- Ex Situ Physical/Chemical Treatment
  - Soil Washing
  - Acid Extraction
  - S/S
  - Chemical Oxidation - Reduction
  - Vitrification
- Ex Situ Thermal Treatment
  - Thermal Desorption
  - Incineration

Figure 3-3 lists the GRAs for the Site 1111 soil contamination, identifies the remedial technologies and process types for each response action, and summarizes the screening results for each technology and process. The following sections describe the technologies and process options under each GRA, along with the rationale for retaining or eliminating each technology.

### 3.4.1 No Action

The no action response was retained for consideration during the development and analysis of alternatives as required by the NCP (40 CFR 300.430[e][6]). The no action response does not provide any additional remediation, containment, or security measures to reduce potential risk to human health or the environment at Site 1111.

### 3.4.2 Institutional Controls

Institutional controls are administrative and physical actions taken to reduce or eliminate risks to public health and the environment by controlling exposure pathways rather than removing contaminants or controlling and reducing their mobility, toxicity, or volume. For soil, institutional control such as access restrictions and fencing are typically considered during the initial screening of technologies to limit exposure of potential human receptors. Institutional controls alone would not be effective because soils at Site 1111 pose a risk to ecological receptors as well as groundwater. The reasonably anticipated future land use at Site 1111 is neither residential nor industrial given its remote location in an ecologically sensitive area. Thus, land use and access restrictions would effectively limit future development and physical access to the site and were retained for

further evaluation. Fencing or barriers may be effective in preventing certain ecological receptors (e g , larger mammals) from accessing the site and contacting site contaminants and was also retained for further evaluation. However, DON's position is to limit the use of institutional controls (where possible) to maximize the utilization of military training lands.

### 3.4.3 Containment

Containment actions for soil contamination are intended to isolate remedial COCs from potential human and/or ecological contact and to protect unimpacted media by reducing or eliminating the migration of remedial COCs from soil to groundwater or surface water systems. The containment option typically is capping (e.g., an asphalt, concrete, or engineered soil cap). At Site 1111 occasional flooding and erosion problems in the area would necessitate an extensive surface water diversion system that makes long-term cap protection and maintenance infeasible. Therefore, this technology was not retained for further consideration in developing remedial alternatives.

### 3.4.4 Removal

Removal actions are intended to remove soils containing remedial COCs. The removal option considered for soil at Site 1111 is excavation.

Under this process option, the contaminated soil is excavated and removed from the site, and the excavated area is backfilled with clean imported soil and compacted to required standards. Excavation is generally followed by treatment and/or disposal of the contaminated soil. This option is particularly suited for source removal A frequent practice is to excavate and remove "hot spots" in combination with other measures such as containment (i.e., capping) of less-contaminated soils. Worker health and safety concerns weigh heavily in the decision to remove highly toxic or reactive waste material.

Other factors considered include contaminant mobility, feasibility of on-site containment or in situ treatment, depth of contamination, and the cost of disposing of the waste or rendering it nonhazardous after excavation

Air monitoring is usually required for this option to demonstrate the effectiveness of dust suppression measures to minimize contaminant exposure potential to workers and off-site receptors. Mechanical excavation using heavy equipment such as a backhoe is feasible at Site 1111 because the vertical extent of contamination is very shallow (average depth 6 feet bgs) and covers a relatively small area (approximately 5,000 square feet) (see Section 3.1.3.1). However, the potential for degradation of sensitive ecological habitat and worker exposure to contamination from implementing this option exists at Site 1111. Appropriate coordination with agencies and implementation of biological monitoring and appropriate mitigation measures would be required. Excavation is readily implementable and was retained for further consideration in evaluating the remedial options for this site.

### 3.4.5 Disposal

This GRA involves disposal of excavated contaminated soil in an appropriate landfill. Two process options were considered under this GRA: on-Base landfilling and off-Base landfilling. These two options are evaluated below

3.4.5.1 On-Base Landfill

This process option involves disposal of excavated soil in an on-Base landfill. There is currently no on-Base CAMU facility at MCB Camp Pendleton, so this option is not feasible and was not retained for further consideration.

3.4.5.2 Off-Base Landfill

Disposal of excavated soil at an off-Base landfill is another process option. Pretreatment of soils would be considered as part of this technology and would be performed either at an on-Base TTU or at the destination landfill to stabilize the waste soil prior to disposal at an off-Base disposal facility. Waste characterization testing would need to be performed during excavation to determine whether the soil exhibits hazardous characteristics that would control the selection of an appropriate disposal facility. Disposal of hazardous waste at a landfill has become increasingly difficult and expensive and is regarded as a less desirable option. However, this process option is potentially applicable and was retained for further evaluation.

### 3.4.6 In Situ Treatment

This GRA encompasses remedial technologies and process options that are designed to treat contaminated soil in place. The main advantage of in situ treatment is that it allows the soil to be treated without being excavated and transported to an off-site disposal facility, resulting in significant cost savings. However, in situ treatment generally requires longer timeframes and there is less certainty about the uniformity of treatment because of the variability in soil characteristics and the difficulty in verifying the efficacy of the process. In situ treatment technologies evaluated for contaminated soil at Site 1111 fall into two broad groups: physical/chemical and biological. Physical/chemical treatment is typically cost effective and can be completed in shorter timeframes than biological treatment. Some technologies combine both physical and chemical treatment processes.

3.4.6.1 Physical/Chemical Treatment

This process option uses the physical/chemical properties of the contaminants or contaminated media to destroy (i.e., chemically convert the contaminants to innocuous compounds), separate, or contain the contamination. Three process options were evaluated under this GRA: soil flushing, solidification/stabilization (S/S), and in situ vitrification.

3.4.6.1.1 In Situ Soil Flushing

In situ soil flushing extracts the contaminants from soil with water or other suitable aqueous solution. Soil flushing is accomplished by passing the extraction fluid through in-place soils using an injection or infiltration process. Soil flushing uses the contaminant's solubility in liquid to separate it from the soil. Surfactants may be added to the flushing solution to increase the contaminant's solubility. Contaminants are leached with the extraction fluid into the underlying groundwater, which is then extracted and treated above ground to appropriate standards prior to recycling or release to local POTWs or receiving streams. Although this technology appears suitable for treatment of metals in high-soil-permeability conditions similar to those at Site 1111, it has no applicability at this site because it would introduce contaminants into the groundwater, which is not a contaminated medium. Therefore, this technology was not retained for further consideration in developing remedial alternatives.

3.4.6.1.2 In Situ Solidification/Stabilization

In situ S/S reduces the mobility of contaminants in soil through both physical and chemical means. In situ solidification seeks to trap or immobilize contaminants within their "host" medium (i.e., soil), instead of removing them through chemical or physical means. This process option works by changing the physical properties of the contaminated soil, rendering it solid (with high structural integrity), and making the contaminants less prone to mobilization via leaching (USEPA, 1986). The solubility of soil contaminants is reduced by encapsulating the contaminants in a solidifying reagent, thereby reducing the surface area exposed to leaching, and/or by coating the contaminated soil with low-permeability materials (USEPA, 2000b).

In situ stabilization treatment processes are intended to convert contaminants to less mobile forms through chemical or thermal interactions. The addition and mixing of stabilizing agents can be achieved either by flooding the ground surface with a liquid stabilizing agent or by allowing it to percolate into the subsurface and react with the target contaminant. Stabilizing agents in either liquid or dry form also can be introduced and mixed with subsurface soil via auger mixing (USEPA, 1997).

In situ S/S limits the mobility of the contaminants, but it does not reduce contaminant concentrations per se. Its effectiveness is highly dependent on homogenous mixing, which can be difficult to ensure in clay-rich soil environments or where the soil contains significant debris (USEPA, 1997). Grout injection bottom barriers (i.e., impermeable horizontal subsurface barriers) can be used to prevent vertical migration by providing a floor of impermeable material beneath the contaminated soil via directional drilling with forced grout injection. Bottom barriers may be necessary at Site 1111 because groundwater is very shallow (6 to 12 feet bgs). In situ technologies also require long-term maintenance (of greater importance for Site 1111, which may be subject to flooding and erosion), post-cure testing, and implementation of land use restrictions. Because of these limitations, this technology was not retained for further consideration in developing remedial alternatives.

3.4.6.1.3 In Situ Vitrification

This technology treats metal-contaminated soil using heat, usually applied through electrical power, to melt the soil at extremely high temperatures (typically 2,900° to 3,600°F). The molten soil forms a stable glass and crystalline structure with very low leaching characteristics that immobilizes the inorganic contaminants by entrapping them or chemically incorporating them in the melt. Because this technology does not destroy many of the metal contaminants but rather traps them inside the matrix, it is often applied to highly concentrated characteristic hazardous waste to meet applicable disposal requirements. There are several disadvantages with this technology. The high temperatures associated with this process produce emissions of toxic vapor from relatively volatile metals (i.e., mercury and lead) that must be captured and treated, the resulting solidified matrix may hinder future site use and necessitate the use of site access restrictions, implementation entails long-term maintenance, and the technology is energy intensive and costly. Because of these concerns, this technology is impractical for application at Site 1111 and was therefore excluded from further consideration.

3.4.6.2 Biological Treatment (Phytoremediation)

Phytoremediation is an emerging technology that uses plants to remove, transfer, stabilize, or degrade chemical contaminants in soil, sediment, or groundwater. There are various applications of phytoremediation technologies; the most appropriate

application to Site 1111 is enhanced rhizosphere biodegradation, which takes place in the soil immediately surrounding plant roots. Natural substances released by plant roots supply nutrients to soil microorganisms enhancing their biological activity. Plant roots also loosen the soil and then die, leaving paths for transport of water and aeration This process facilitates the movement of soil moisture to the surface zone.

Research has shown that plants can be used to treat most classes of compounds including metals. Plant species are selected on the basis of their potential to evapotranspirate groundwater, the degradative enzymes they produce, their growth rate and yield, the depth of their root zone, and their ability to bioaccumulate contaminants. Although certain plants allow uptake from deeper zones, phytoremediation is best suited for use in soils that are within 2 to 3 feet bgs and are contaminated with intermediate concentrations of organic waste

For Site 1111, phytoremediation was not judged to be implementable due to limited vertical effectiveness of the technology, the few demonstrated successful applications of this technology to treat the range of COCs at the site at the observed concentrations, and the fact that it will not eliminate ecological exposure to COCs. Also, it may increase contaminant mobility via plant uptake, making COCs more available and allowing continued long-term exposure to ecological receptors. Also, the concept of excavating the soil to allow use of phytoremediation is not considered cost-effective since the cost of excavation, placement, maintenance, design, construction and operation of an ex-situ phytoremediation treatment system would rival the cost of excavation and disposal. For these reasons, phytoremediation was excluded from further consideration for this site.

### 3.4.7 Ex Situ Treatment

The main advantage of ex situ treatment is that it generally requires less time, and there is greater certainty about the uniformity of treatment because of the ability to monitor and thoroughly mix the contaminated soil. Ex situ treatment, however, requires excavation of the contaminated soil to the ground surface for treatment and subsequent disposal of the treated soil at an appropriate facility or beneficial reuse as fill or construction material. Compared to in situ treatment, these ex situ options lead to increased costs and engineering support for treatment equipment, permitting, and material handling and disposal. Ex situ treatment technologies that were evaluated for metal-contaminated soil at Site 1111 fall into two broad groups: physical/chemical and thermal.

#### 3.4.7.1 Physical/Chemical Treatment

Soil washing, acid extraction, S/S, and vitrification were considered as potentially applicable ex situ physical/chemical treatment options for Site 1111.

##### 3.4.7.1.1 Ex Situ Soil Washing

Soil washing is a water-based volume reduction process for scrubbing soils ex situ to remove contaminants. This process removes heavy metals from soil by suspending them in the wash solution, or by concentrating them into a smaller volume of soil through particle size or gravity separation. Washing processes that separate the fine clay and silt particles from the coarser sand and gravel particle can effectively separate and concentrate the contaminants into a smaller volume of soil that can undergo further treatment/disposal. The wash water can be augmented with pH adjustment, a leaching agent, or a chelating agent. The contaminated water generated from the process also requires further treatment. Soil washing is generally considered a media transfer technology and is ineffective in achieving cleanup goals when used alone. This process

option has seen limited use in the United States. Because of these issues, it was eliminated from further consideration.

3.4.7.1.2 Ex Situ Acid Extraction

Acid extraction uses acidic (hydrochloric acid) reagents to extract heavy metal contaminants from soils. In this process, soil is first mechanically screened to remove coarse solids. Because metals are generally found on the finer soil particles such as clays and humic material, the fine soil particles containing the bulk of the metals are separated in this process, thus considerably reducing the mass of contaminated soil requiring further treatment. Hydrochloric acid is then thoroughly mixed with the separated fine soil in the extraction unit. Residence times generally range between 10 and 40 minutes depending on the soil type, contaminants, and contaminant concentrations. The soil-extraction mix is continuously pumped out of the mixing tank and the soil and extractant separated using hydrocyclones. The resulting "cleaned" soil is then filtered, rinsed, dried, and disposed of or reused. Any residual acid in the treated soil also must be neutralized. The extraction solution and rinse water are typically hazardous and can be regenerated using commercially available precipitants, such as sodium hydroxide (NaOH) or lime, along with a flocculent that removes the metals and reforms the acid. The removed heavy metals are concentrated in a form that is suitable for recovery. These residues often require additional treatment such as S/S or vitrification. Offgases from the process also require collection and treatment. Elevated temperatures associated with the process raise concerns of toxic metallic vapor emissions, which can be difficult to control.

This process option is applicable for organic materials but only partially oxidizes the metals that constitute the soil remedial COCs at Site 1111. Meeting stringent heavy metal cleanup criteria (i.e., California WET) may prove uneconomical. Capital costs can be relatively high, and the technology is typically economical only at larger sites. In addition, hazards associated with the handling of acids and residues following extraction suggest that implementation of this process option could be difficult. For these reasons, acid extraction was eliminated from further consideration.

3.4.7.1.3 Ex Situ Solidification/Stabilization

Solidification refers to techniques that encapsulate the waste in a monolithic solid of high structural integrity. Stabilization refers to those techniques that reduce the hazard potential of a waste by converting the contaminants into their least soluble, mobile, or toxic form. In ex situ S/S, contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). There are many innovations of this technology; most of them modifications of proven processes directed at encapsulating or immobilizing the contaminants by processing the contaminated soil. Ex situ S/S is often accomplished by mixing the excavated soil with stabilizing agents or binders, such as pozzolan/Portland cement, phosphate, lime, soluble silicates, sulfur-based additives, or proprietary agents to limit the solubility of metals or detoxify them. Following S/S, the treated soil may be eligible for use as construction fill material. Metals-impacted soil can also be stabilized and recycled by mixing with stabilizing reagents, organic emulsions, and aggregate to form cold-mixed asphalt, which can be used as a commercially viable construction material. This technology was thoroughly evaluated in the OU 4 FS (Parsons, 2003a), and was further investigated by the DON Tiger Team, which ultimately concluded that the technology was infeasible because of

the need to ensure that stabilized soils pass the CA-WET extraction test and the need for a large construction project that can utilize large quantities of treated soil.

At Site 1111, the impacted soil contains locally abundant anthropogenic debris, such as scrap lumber, glass, and other miscellaneous refuse. The effectiveness of stabilization is highly dependent on uniform mixing, which may be difficult to achieve with the debris-laden materials at Site 1111. Furthermore, anthropogenic debris, if present in large quantities (which is probable at this site), could require a separate and distinct remedial technology, which would render the cleanup more complicated and costly. For these reasons, this technology is judged impractical for Site 1111 and was excluded from further consideration.

#### 3.4.7.1.4 Ex Situ Vitrification

Ex situ vitrification processes are stabilization/solidification methods that employ heat between 1,900° to 3,600°F to melt and convert waste materials into a glass matrix (USEPA, 1997). The high temperatures destroy organic constituents with very few by-products. Inorganics such as heavy metals are incorporated into a stable, relatively strong, and durable glass structure that is very resistant to leaching and has mechanical and chemical properties similar to granite. Vitrification is an energy-intensive and costly technology, not readily implementable, and difficult to ensure homogeneous melting and control emissions of toxic vapors of the relatively volatile metals (i.e., lead) of concern at Site 1111. Therefore, this technology is impractical for Site 1111 and was excluded from further consideration.

### 3.4.7.2 Thermal Treatment

Thermal processes use heat to increase the volatility (separate); burn, decompose or detonate (destroy); or melt (immobilize) the contaminants. Thermal desorption and incineration were considered as potentially applicable ex situ thermal treatment process options and are evaluated below.

#### 3.4.7.2.1 Ex Situ Thermal Desorption

Thermal desorption is a separation technology that uses heat in a controlled environment to volatilize and remove contaminants from the soil. The technology is not designed to destroy organics. A carrier gas or vacuum system transports volatilized water and organics to an off-gas treatment system. The gas used can be air or an inert gas such as nitrogen. Indirect heating is applied to avoid combustion. The temperature range is usually 300° to 1,200°F (lower than that of incineration), although higher temperatures can be used with an inert gas (USEPA, 1997). Because the operating temperature for this technology is typically far below the boiling point of metals, it is generally ineffective for metals. In addition, volatilization of the relatively volatile metals (i.e., mercury and lead) and generation of toxic fumes could pose operational and worker safety difficulties. Therefore, thermal desorption was eliminated from further consideration.

#### 3.4.7.2.2 Ex Situ Incineration

Incineration, which can be implemented on or off site, refers to a thermal treatment that destroys organic contaminants by oxidizing them at high temperatures. The two most important parameters for effective destruction of contaminants are temperature and residence time (Freeman, 1989). These two parameters are different for different incineration process designs. The two most commonly used designs are fluidized bed and rotary kiln incinerators. Incineration could be applicable for treatment of organics

and diesel contamination, but it is ineffective for treatment of metals because a large percentage of the relatively volatile metals (e.g., lead and mercury) would be emitted as toxic vapors that are difficult to control. Another problem with incineration of metals is that they are not completely destroyed and generally are present in the ash residue, which may require additional treatment and disposal. Finally, because metals have little heat recovery value, system operation is ineffective, costly, and impractical. Therefore, incineration was eliminated from further consideration

## 3.5 Evaluation of Technology Process Options

Technologies and process options judged to be potentially viable in the previous section for Site 1111 contaminated soil are reviewed according to three criteria: effectiveness, implementability, and cost These criteria are briefly discussed below.

- **Effectiveness.** The effectiveness evaluation focuses on the following elements:
  - Potential effectiveness of process options for handling the estimated areas or volumes of media and meeting the RGs identified in the RAOs
  - Potential impacts to human health and the environment during the construction and implementation phase
  - Reliability and proven effectiveness of the process with respect to the contaminants and conditions at the site
- **Implementability.** The initial technology screening eliminated technology types or process options that were clearly ineffective or unworkable at the site. This evaluation addresses both the technical and institutional feasibility of implementing each process including the following institutional aspects:
  - Ability to obtain necessary permits and rights-of-way for off-site actions
  - Availability of necessary equipment and skilled workers to implement the technology
  - Availability (including capacity) of treatment, storage, and disposal services
- **Cost.** Cost plays a limited role in the screening of technologies at this phase. Relative capital and O&M costs are considered rather than absolute costs. For this evaluation, the cost analysis is based on engineering judgment. Each technique is evaluated as to whether costs are low, moderate, or high relative to other process options in the same technology type. The greatest cost consequences in site remediation are usually associated with the degree to which different technology types are used. Using different process options within a technology type usually has a less significant effect on cost than the use of different technology types. A technology process option can be eliminated on the basis of cost only if other process options within the same technology type are comparably effective and implementable but have a much lower cost.

Figure 3-4 lists all the technologies and process options that passed the initial screening in the previous section. Based on the above criteria, the process options were evaluated relative to other processes within the same technology type to select a representative process option to be included in a remedial alternative. At this stage of the FS, the emphasis is on the effectiveness of each option; implementability and cost are of lesser importance. Each criterion is rated as low, moderate, or high relative to the technologies

within the same process option. The results of the evaluation are discussed in the following sections and are summarized in Figure 3-4.

### 3.5.1 No Action

The evaluation of the no action option for soil contamination at Site 1111 is summarized below:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Contaminants would remain in the soil. The effectiveness is rated low because both human and ecological receptors could be exposed to the contaminated soil. RAOs are not achieved. | Low |
| Implementability | No equipment, skilled workers, or permits are required. | High |
| Cost | No cost is associated with no action. | High |

The no action option is retained for incorporation into remedial action alternatives, as required by the NCP, and will be used as a baseline for comparison of other options.

### 3.5.2 Institutional Controls

Access/use restrictions were retained for further evaluation. Access restriction involves limiting site access and future use/development by implementing land use controls in accordance with DoD policy.

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Contaminants would remain in the soil. Access restriction would effectively reduce the human health exposure pathway, but it would be only partially effective to protect ecological receptors and groundwater | Low |
| Implementability | Readily implementable. However, DON's position is to limit the use of institutional controls (where possible) to maximize the utilization of military training lands. | Moderate to High |
| Cost | Low capital or O&M costs | High |

Access and use restrictions are further retained for incorporation into the remedial action alternatives.

### 3.5.3 Containment

No containment technologies were retained for Site 1111 after the initial screening phase.

### 3.5.4 Removal

The evaluation of the removal option for soil contamination at Site 1111 is summarized as follows:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Demonstrated ability to meet RAOs but it does not reduce contaminant mobility or toxicity without treatment. | High |
| Implementability | Necessary equipment and skilled labor typically available. Requires agency approval, Base coordination, and health and safety planning. Potential for degradation of sensitive ecological habitat. | Moderate to High |
| Cost | High capital costs, low O&M costs | Moderate |

The removal option is an important strategic option available to support remedial actions at Site 1111 and is retained for further consideration in the development of remedial alternatives.

### 3.5.5 Disposal

The disposal of excavated soil at an off-Base landfill was retained from the initial screening phase.

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Demonstrated ability to meet RAOs. Reduces contaminant mobility and toxicity through pretreatment to stabilize waste prior to disposal. | High |
| Implementability | Necessary equipment and skilled labor typically available. Off-Base disposal of hazardous waste is considered a worst-case alternative and is becoming an increasingly difficult and expensive option. | Moderate to High |
| Cost | Off-Base disposal site: High capital and low O&M costs. | Moderate |

Disposal at an off-Base landfill is an important strategic technology option available to support remedial actions at Site 1111 and is retained for further consideration in the development of remedial alternatives.

### 3.5.6 In Situ Treatment

No in situ treatment technologies were retained after the initial screening phase.

### 3.5.7 Ex Situ Treatment

No ex situ treatment technologies were retained after the initial screening phase.

### 3.5.8 Summary of Process Option Selection

As illustrated in Figure 3-4, all the process options evaluated for remediation of heavy metal contamination in soil at Site 1111 are summarized below:

- The no action response is retained as required by the NCP.
- Access/use restrictions and periodic site inspection/monitoring are selected as institutional controls.

- Mechanical excavation is the selected process to remove contaminated soil from the site.
- Disposal at an off-Base permitted hazardous waste facility was retained as a viable disposal option.

The selected process options provide the basis for the development of alternatives as discussed in the following section.

## 3.6 Development and Detailed Analysis of Remedial Alternatives

Guidance for the development of remedial alternatives for Site 1111 was obtained from the following sources:

- 40 CFR 300 (NCP)
- Section 121 of SARA
- Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, 1988)
- Navy/Marine Corps Installation Restoration Manual (U.S. Navy, 1997)

As required by the NCP and recommended by USEPA guidance (USEPA, 1988), acceptable engineering practices that relate to site-specific conditions were considered during development of the remedial action alternatives. The alternatives developed satisfy the requirements of 40 CFR 300.430(e), which specifies that alternatives be developed to include no action, institutional controls, little to no treatment alternatives, and alternatives that reduce the toxicity, mobility, or volume of contaminants, to the extent practical.

The process options selected for Site 1111 in the previous section were assembled into specific alternatives representing possible remedies for the soil contamination at the site. Because of the limited number of process options retained for further consideration, few potential remedial alternatives are appropriate for Site 1111. Therefore, screening of alternatives was not necessary for Site 1111. All the alternatives developed were carried forward into the detailed analysis.

### 3.6.1 Overview of Detailed Analysis and Nine NCP Evaluation Criteria

An overview of detailed analysis and nine NCP evaluation criteria is presented in Section 1.6 of this report.

### 3.6.2 Description of Remedial Alternatives for Soil

Alternatives were developed to address the remedial COCs for Site 1111 listed in Table 3-2. As illustrated in Figure 3-2, the estimated total area of impacted soils is approximately 5,000 square feet. The impacted soils extend to approximately 6 feet bgs. The estimated total in-place volume of impacted soil is 1,100 cubic yards.

The following three alternatives were developed for remediation of contaminated soil at Site 1111:

- Alternative 1111-S1: No action
- Alternative 1111-S2: Institutional controls (site access restrictions with land use controls, periodic site inspection/monitoring)

- Alternative 1111-S3: Soil excavation, backfill, pretreatment, and off-Base disposal

#### 3.6.2.1 Alternative 1111-S1: No Action

The NCP (40 CFR 300.430[e][6]) requires that a no action alternative be evaluated. Under this alternative, no further action would be taken to control or clean up the soil contamination at Site 1111 to reduce potential risks to human health and the environment. The no action alternative involves no remediation of soils and results in no disturbance to the existing environment.

#### 3.6.2.2 Alternative 1111-S2: Institutional Controls

This alternative implements institutional controls at Site 1111 to reduce the risk to human health and the environment by controlling and monitoring exposure pathways rather than removing or controlling the risk source. Institutional controls refer to measures other than engineering control and treatment technologies. The institutional controls in Alternative 1111-S2 include implementing restrictions on the site's future development and use, as well as periodic site inspection/monitoring of the site to prevent unauthorized use.

The intent of the land use restrictions is to limit activities that would increase the potential for exposure of receptors to buried materials. Future use of Site 1111 for residential or industrial purposes would be controlled by enforcing these land use restrictions. Details of the site's institutional controls would be incorporated into the land use control documents per DoD guidance. To limit erosion and reduce the potential for exposure of human and ecological receptors to the buried materials, the site would be inspected periodically during the rainy season for evidence of erosion. If required, measures would be implemented to limit or control site erosion.

Alternative 1111-S2 represents minimal administrative actions and physical measures to restrict site access in order to temporarily reduce and control exposure risks, but it does not involve any active remediation of the contaminated soil to eliminate exposure risk. Monitoring is expected to continue as long as wastes remain at the site.

If institutional controls, or land use controls, are chosen as the selected remedy for this site, a detailed description of the institutional controls or land use controls will need to be included in the ROD and Remedial Action Plan (RAP). The DON memo titled *Monitoring and Enforcement of Land Use Controls* (U.S. Navy, 2003) provides specific items to be included in the ROD and RAP, including listing the parties responsible for enforcing the land use controls, and the need for five-year reviews.

If institutional controls are selected to be all or part of the remedy for the OU 5 sites, such controls will be implemented by MCB Camp Pendleton as part of the site approval process. Site approval is required for all projects at the Base involving construction, acquisition, or modification. Once site approval is requested, MCB Camp Pendleton Environmental Security must be consulted for environmental approvals, including for NEPA determination if applicable. The form that is used to initiate the site approval process is called the "Preliminary Environmental Data Sheet." Currently Mark Bonsavage is the primary point of contact for projects potentially affecting IR sites. If Mark vacated the position, whoever assumed the roll of IRP Manager would review the site approvals.

The role of Environmental Security in the site approval process includes maintaining a GIS system for environmental constraints at the Base, including wetlands, sensitive species, and IR sites. If a planned activity requires environmental review or falls within an area specified on the Environmental Operations map, Environmental Security must review the proposed actions and make recommendations.

3.6.2.3 Alternative 1111-S3: Soil Excavation, Backfill, and Off-Base Disposal

Alternative 1111-S3 addresses remediation of contaminated soils exceeding the RGs through excavation and off-Base disposal. The logistics associated with the implementation of Alternative 1111-S3, including utilities, would be addressed in a Remedial Action Work Plan for the site. The siting, location, and excavation for utilities are therefore not discussed in detail in this document. The following elements are associated with Alternative 1111-S3:

- Excavation of impacted soil
- Temporary storage of excavated soil stockpiles
- Sampling and analysis of soil stockpiles for waste characterization
- Transportation of the excavated soil to an off-Base disposal facility
- Confirmation sampling and analysis of excavation areas
- Import and compaction of backfill material
- Site restoration.

Based on the volume of material (approximately 1,100 cubic yards) exceeding the RGs cited in Section 3.1.3.2 (i.e., background and/or industrial PRGs), approximately 2,200 tons would require excavation from Site 1111 (Appendix F2). The excavation area is irregularly shaped, measuring roughly 80 by 100 feet and approximately six feet deep (Figure 3-2). The estimated depth of six feet is based on the risk to human health or ecological receptors and that the groundwater table is present at approximately six feet. Note that if soils are excavated, RGs will be met in the confirmation samples, and it may be necessary to go below the water table to achieve that goal. For costing purposes however, six feet is considered appropriate because there are portions of the excavation that will likely not need to be that deep. Within this area, approximately 5,000 square feet (0.11 acre) is impacted with COCs above site RGs. Based on the data and waste classification discussed in Appendix F2, approximately 550 cubic yards (1,100 tons) of the excavated soil would be classified as California-hazardous, and approximately 550 cubic yards (1,100 tons) would classify as RCRA-hazardous waste. Although it is hypothetically possible that less than the estimated 1,100 cubic yards could be removed and still meet the soil RGs, it is assumed in this document that the full 1,100 cubic yards will require excavation to meet the RGs. This is due to two reasons: 1) the soils inside the defined "hot spot" show consistently and significantly higher concentrations than those outside the hot spot; therefore, the extent of these significantly higher concentrations are well defined, and 2) there may be heterogeneity in the hot spot soils that result in unexpectedly high concentrations of COCs or debris at any point in the hot spot soils.

Heavy earthmoving equipment, such as a track-mounted excavator and track- or wheeled- loaders would be used to excavate the impacted soil within the lateral limits. During soil removal, the excavation would progress vertically and laterally to remove the areas of identified soil contamination exceeding the RGs. The excavation sidewalls

would be sloped at 1.5:1 (horizontal:vertical) to maintain slope stability and avoid the use of shoring.

Following excavation to the assumed lateral limits and target depth, confirmation samples would be collected for laboratory analysis. Confirmation sampling would be performed shortly after excavation has been completed, so that, to the extent possible, sampling would be performed concurrent with excavation. The remedial COCs for this site are VOCs, SVOCs, dioxins, pesticides, and metals; therefore, confirmation samples would be analyzed for these compounds, and the results compared to the remedial goals established for the cleanup. Approximately one confirmation sample would be collected from each 20- by 20-foot (400-square-foot) area of the excavation. Along the perimeters of the excavation area, some of these samples would be collected from the excavation sidewalls or slopes and from the excavation floor. Based on the analytical results from the confirmation samples and comparison to RGs, the excavation would be backfilled or extended laterally and/or vertically until the cleanup goals are achieved. If additional excavation were required, additional confirmation sampling and analysis would be performed until the cleanup goals are met.

A licensed land surveyor would survey the final spatial limits of the excavation after confirmation sampling and analysis and prior to placement and compaction of backfill. After excavation and confirmation sampling had been completed on a few contiguous grids, placement of backfill and compaction would be initiated. To the maximum extent possible, backfill and compaction would be performed concurrently with excavation and confirmation sampling. Prior to placement of backfill, the exposed bottom of the excavation would be moisture conditioned and the excavation backfilled with imported clean soil. All backfill material would be placed in lifts, moisture conditioned, and compacted. Compaction tests would be performed during the backfill operation to document the percent relative compaction of the soil. The excavation would be backfilled to the original surface contours, surveyed, and revegetated to restore habitat and to minimize erosion.

For Site 1111, a TTU will not be cost effective for treatment of impacted material due to the limited volume of material to be removed. Therefore, it is assumed that the excavated material will be stockpiled, sampled, and characterized based on the stockpile sample results. There is the potential that a portion of the material would be classified or manifested as RCRA waste (i.e., "D008-listed" for lead) and may be subject to the universal treatment standards (UTSs) of the land disposal restrictions (LDRs).

If excavation and off-Base disposal is chosen as the preferred remedial alternative, cost savings may be achieved by modes of transport other than trucking, such as use of trains for all or part of the transport. Also, it is possible that cost savings may be achieved if multiple sites are addressed at the same time. For the purposes of the cost estimate in this FS, however, all soil excavation and disposal is assumed to be on a site-by-site basis, and that trucking of waste will be the exclusive means of transport. This allows for a direct comparison of costs between sites using the same set of assumptions.

During the remedial action, the excavation and stockpile areas would be delineated with barricades, caution tape, and warning signs to restrict unauthorized access to these areas. Potential exposure and protection procedures for site workers would be addressed in a site-specific health and safety plan. The risk of exposure for site personnel to soil contaminants would be minimized by proper selection of PPE;

establishing support, contaminant reduction, and exclusion zones; application of suppressants to reduce dust emissions in the excavation and at the stockpile areas; and monitoring dust using direct-reading instruments. Detailed field procedures for the management and maintenance of an open excavation area and temporary soil stockpile would be provided in the remedial action documents.

A medium-sized tracked excavator (Caterpillar 235 or equivalent) would be used to excavate the soil and place it in small stockpiles adjacent to the working face of the excavation. Large capacity front-end loaders would then transfer the soil from the stockpile to awaiting 23-ton end dump trucks for transport and disposal. Plastic sheeting would be required to protect the ground surface beneath the loading area to protect underlying soils. The stockpiles would be periodically wetted and regularly monitored to ensure control of fugitive dust emissions. The water applied during dust control activities would be applied in a fashion so as to eliminate the potential for erosion. Stockpiles would be in continuous motion during excavation and loading of materials for disposal. However, at the end of each day, stockpiles would be covered with Visqueen (plastic) sheeting and secured with sand bags.

Prior to transport, composite stockpiles samples would be collected and the analytical results would then be used to characterize and classify the waste. The cost estimate in Appendix F2 is based on a 5-day work weeks (8 hours per day), resulting in 35 calendar days (or approximately 5 weeks).

In preparing this alternative, soil that would be excavated was first subjected to a waste classification procedure based on the RI data (Appendix F2). However, if this alternative were implemented, then waste classification (prior to manifesting, transport, and disposal) would need to be determined based on the results of stockpile sampling and analysis. Based on the concentrations of compounds detected at the site only lead has concentrations that would exceed hazardous waste characterization/classification levels. Therefore, stockpile samples would be analyzed for soluble lead by the following two test procedures: the TCLP (SW1311), as described in USEPA Publication SW 846, and the California WET analysis (22 CCR Chapter 11). The results for the WET analyses would be compared to the STLCs to determine if the waste classifies as California hazardous. Likewise, the results from the TCLP tests would be compared to the TCLP criteria to determine if the waste classifies as RCRA hazardous. Using these results and appropriate regulations governing classification of hazardous waste, each soil stockpile would be classified as RCRA-hazardous, California-hazardous, or nonhazardous waste. Logistic considerations permitting, it may be possible to perform some of the testing in an iterative manner so that the results from WET analyses would be compared to STLC levels prior to analysis by TCLP.

For estimating purposes, it is assumed that all RCRA and California-hazardous soil would be transported, under Uniform Hazardous Waste Manifest, to Waste Management's Kettleman Hills Facility in Kettleman City, California for treatment and/or disposal. If, based on results of stockpile samples, a portion of the material is determined to be nonhazardous, this soil would be transported under a Bill of Lading to the Waste Management Bradley Facility in Tujunga, California. All required placards would be placed on vehicles prior to leaving the site. All federal and California DOT guidelines and regulations would be followed. Each transport truck is expected to haul permanently 18 cubic yards (23 tons) of soil to the disposal facility. To ensure that trucks do not exceed the public highway weight limits, calibrated portable scales would be placed on site and operated by a certified weigh master. An average rate of 15 minutes per transport truck is estimated for loading, weighing, and tarping; therefore, 32

trucks could be loaded in each 8-hour shift. Transportation and waste profiling of the excavated soil would occur concurrently with excavation.

The total duration of the remedial action is expected to be 5 calendar weeks, based on an excavation, transportation, and disposal at a rate of 500 cubic yards (1,000 tons) per day. The mobilization would require 2 days. Excavation and stockpiling (including sampling) would require approximately 1 week. Loading, transport and disposal would require 3 days. Confirmation sampling and analysis would extend approximately 1 week beyond the excavation, assuming the standard laboratory turn-around time (1 week). After all excavation and confirmation sampling/analysis are complete, backfill and compaction would extend approximately another 1 week. Site cleanup and restoration (final grade check, surveying, and revegetation) would require another 1 week.

### 3.6.3 Detailed Analysis of Site 1111 Remedial Alternatives

This section presents a detailed analysis of the three remedial alternatives that were developed for Site 1111. The detailed analysis of remedial alternatives consists of evaluating each selected alternative against seven of the nine NCP evaluation criteria (state and community acceptance will be evaluated in the future). The objective of the detailed analysis is to present and interpret the relevant information necessary to select the most appropriate and cost-effective remedy for a site to meet the RAOs. The detailed analysis is designed to provide decision-makers with sufficient information to compare the alternatives, select an appropriate remedy for the site, and demonstrate conformance with the CERCLA remedy selection requirements in the ROD (Table 3-2). All three alternatives for Site 1111 were selected for the detailed analysis.

#### 3.6.3.1 Overall Protection of Human Health and the Environment

An analysis of how well each alternative meets overall protection of human health and the environment is provided below.

Alternative 1111-S1: No Action

The no action alternative includes no treatment and no control of exposure pathways. Under this alternative, the potential long-term risks would be the same as those calculated in the baseline HHRA and the ecological risk assessment and would not be protective of human health and the environment. In addition, the site is located in the floodplain and the contaminated soils could wash out if the area was flooded.

Alternative 1111-S2: Institutional Controls

Under current conditions, Alternative 1111-S2 would provide for control of human exposure pathways through land use restrictions and periodic site inspections and monitoring. However, because the site is located in a stream valley, contaminants could eventually wash out and potentially impact surface soil and water if the area is flooded. Also, this alternative would not be protective of ecological receptors. Therefore, this alternative would provide only limited short-term protection to human health since human and ecological receptors could still come in contact with contaminated surface and near-surface soils in the event of a flood.

Alternative 1111-S3: Soil Excavation, Backfill, and Off-Base Disposal

Alternative 1111-S3 would protect human and ecological receptors because all contaminated soil exceeding chemical-specific RGs would be physically removed, transported off Base, and backfilled with clean import soil. Residual contamination

would meet RGs and would therefore be protective of human health and the environment.

3.6.3.2 Compliance with ARARs

An analysis of how well each alternative complies with ARARs is provided below.

Alternative 1111-S1: No Action

No action-specific ARARs are identified for the no action alternative because no action is taken. Based on the previously performed screening-level ERA, Alternative 1111-S1 would not comply with location-specific requirements of the Endangered Species Act and RCRA requirements for sites located within a floodplain. In addition, Alternative 1111-S1 would not comply with site-specific water quality objectives and beneficial uses since the site is located within a floodplain.

Alternative 1111-S2: Institutional Controls

Because elevated levels of COCs in excess of the proposed remediation cleanup goals would remain at the site, post-closure care is required. Alternative 1111-S2 partially meets this requirement by providing use restrictions and site monitoring/maintenance for surface soil erosion. Based on the previously performed screening-level ERA, Alternative 1111-S2 would not comply with location-specific requirements of the Endangered Species Act and RCRA requirements for sites located within a floodplain. In addition, Alternative 1111-S2 would not comply with site-specific water quality objectives and beneficial uses since the site is located within a floodplain.

Alternative 1111-S3: Soil Excavation, Backfill, and Off-Base Disposal

Alternative 1111-S3 complies with ARARs, including air permitting, waste pile, and RCRA requirements for hazardous waste treatment, storage, and disposal. The clean closure requirements in 22 CCR 66264.111 (a) and (b) are met by excavating soils with concentrations of contaminants in excess of the proposed remediation cleanup goals. The historical and cultural resources protection requirements of 36 CFR 800.3 and 800.4 and 32 CFR 229.1 are identified as potential ARARs. Although no resources are known to exist at the site, excavation activities would be monitored for potential identification of unknown cultural resources because these resources have been recorded in the area. San Diego APCD Rule 50(d)(1) is an ARAR for the discharge of particulate matter via fugitive dust emissions during excavation, handling, and transportation activities. Soils would be wetted and covered with a synthetic material or soil polymer to meet the air requirements.

It is likely that Alternative 1111-S3 would comply with action- and location-specific requirements of the Endangered Species Act, although coordination with the USFWS would be required. Additional coordination with SHPO and appropriate Native American groups would be needed to comply with the Archeological and Historic Preservation Act.

3.6.3.3 Long-Term Effectiveness and Permanence

An analysis of the long-term effectiveness and permanence for each alternative is provided below.

Alternative 1111-S1: No Action

The risks associated with the no action alternative were evaluated in the baseline human and ecological risk assessments. This alternative would not provide actions or controls to reduce existing contaminant concentrations or risks to human health or the

environment. As a result, the reliability and adequacy of actions or controls is not evaluated for no action. No action is not considered to provide long-term effectiveness and permanence because contaminated material would remain at the site. The site is located in the floodplain and no action also does not prevent the possible erosion of existing contaminated soils. In addition, site waste is a long-term, significant, and continuous source of pollutants to water quality that may limit the ability in the future to access and/or develop water resources in the vicinity and down gradient of the site.

Alternative 1111-S2: Institutional Controls

This alternative would be effective in controlling potential human exposure to buried material, contaminated soils, and would limit future site development. Alternative 1111-S2 would require long-term maintenance and would provide a degree of effectiveness through limiting exposure and site uses. However, given the site's location within the floodplain, the potential for flooding to expose contaminated soils, and the risk posed to ecological receptors by baseline conditions, this alternative does not provide long-term effectiveness and permanence for human or ecological receptors. In addition, site waste is a long-term, significant, and continuous source of pollutants to water quality that may limit the ability in the future to access and/or develop water resources in the vicinity and down gradient of the site.

Alternative 1111-S3: Soil Excavation, Backfill, and Off-Base Disposal

This alternative would provide a high degree of long-term effectiveness and permanence because contaminants are removed from the site and the contaminated soil is replaced with clean import soil. The excavation of contaminated soil provides a permanent solution for protecting human receptors and results in an adequate and reliable reduction of exposure pathways. This alternative satisfies the RAO. Removal and off-site disposal of the contaminated soil would result in acceptable levels of residual soil contamination from both a human and ecological perspective.

#### 3.6.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

An analysis of the reduction of toxicity, mobility, or volume through treatment for each alternative is presented below.

Alternative 1111-S1: No Action

Because active treatment is not a component of this alternative, there is no reduction in toxicity, mobility, or volume of soil through treatment.

Alternative 1111-S2: Institutional Controls

Because treatment is not a component of this alternative, there is no reduction in toxicity, mobility, or volume of soil through treatment.

Alternative 1111-S3: Soil Excavation, Backfill, and Off-Base Disposal

Because treatment is not a component of this alternative due to the limited volume of material to be removed, there is no reduction in toxicity, mobility, or volume of soil through treatment.

#### 3.6.3.5 Short-Term Effectiveness

An analysis of the short-term effectiveness for each alternative is provided below.

Alternative 1111-S1: No Action

No remedial actions would be implemented under the no action alternative; therefore, effectiveness during implementation cannot be evaluated.

Alternative 1111-S2: Institutional Controls

Implementation of use restrictions is administrative and presents no short-term effectiveness issues. Implementation of Alternative 1111-S2 is not expected to result in any significant adverse environmental impacts. Site 1111 has already been disrupted by episodic vehicle traffic and implementation of Alternative 1111-S2 would not result in any significant impact to vehicle traffic in the area of the site.

Alternative 1111-S3: Soil Excavation, Backfill, and Off-Base Disposal

The short-term effectiveness for Alternative 1111-S3 is rated moderate. A site-specific sampling plan as well as a site-specific health and safety plan would be prepared and implemented. Potential exposure and protection procedures for workers would be addressed in the health and safety plan. Potential short-term risks to site workers would include inhalation of fugitive dust, dermal contact, and ingestion of impacted site soil during excavation and pretreatment.

Heavy equipment operated at the site would conform to Cal/OSHA specifications and would be operated only by authorized, trained personnel. The contaminated soil would be transported to the selected off-Base disposal facility in covered trucks traveling on public highways. Prior to leaving the site, trucks would be thoroughly inspected to ensure that no loose contaminated soil, which could present a hazard to the public, is present on the outside of the trucks. Traffic accidents associated with driving public highways could occur in the course of soil transportation. In the case of a traffic accident, the risk to the public would be from exposure to dust from contaminated soil, in addition to the risk of physical harm due to the accident. Risks associated with exposure of site personnel and nearby receptors to dust emissions and/or direct contact with contaminated soil during excavation and stockpiling would be minimized by using dust suppressants and/or appropriate PPE, where applicable.

Implementation of Alternative 1111-S3 is not expected to result in any significant adverse environmental impacts. The area in Site 1111 subject to remediation has already been disrupted by episodic vehicle traffic. Some short-term impacts to ecological receptors and habitat could occur, but adverse effects would be minimized through close coordination with the appropriate regulatory agencies (i.e., USFWS). The areas affected during remediation would be backfilled and habitat restored in affected areas following completion of the remedial alternative.

Field personnel participating in the excavation, treatment, and sampling activities would wear PPE, as specified in the health and safety plan. The remedial activities in this alternative are expected to be completed in less than 1 year.

#### 3.6.3.6 Implementability

An analysis of the implementability of each alternative is provided below.

Alternative 1111-S1: No Action

No implementability concerns are posed by this alternative because no action would be taken.

Alternative 1111-S2: Institutional Controls

Institutional actions comprising this alternative are readily implementable. Modifications to the land use controls documents per DoD guidance are administrative in nature. The Base would have primary responsibility for implementing this alternative and possesses the authority and capability to establish appropriate safeguards and to monitor and enforce compliance. Existing staff within the Base Environmental Security Office coordinate all on-Base construction activities to ensure appropriate environmental review. Institutional controls for IR sites are maintained on a central GIS that is readily accessible. Furthermore, the 5-year review process provides an additional level of review to ensure that the site is not used inappropriately.

Implementation of Alternative 1111-S2 would require coordination with the USFWS to ensure that this alternative would be protective of ecological receptors and complies with requirements of the Endangered Species Act. Based on the previously performed screening-level ERA, it is unlikely that these agencies would allow this alternative to be implemented because it would not be protective of ecological receptors. In addition, the DON's position is to limit the use of institutional controls (where possible) to maximize the utilization of military training lands.

Alternative 1111-S3: Soil Excavation, Backfill, and Off-Base Disposal

Implementability is ranked high for Alternative 1111-S3. Excavation and disposal of contaminated soil at an off-Base disposal facility are readily implementable. Several firms can provide the necessary equipment, materials, and labor to excavate and dispose of the contaminated soil. Licensed disposal facilities capable of accepting the contaminated soil currently exist within California.

Because the majority of the impacted soil would be permanently removed from the site, future soil remedial activities are not expected to be necessary. Collecting and screening confirmation samples during excavation would be used to evaluate the effectiveness of soil excavation.

Implementation of Alternative 1111-S3 would require coordination with the USFWS to ensure that this alternative would be protective of ecological receptors and complies with requirements of the Endangered Species Act. In addition, cultural resources coordination (SHPO and Native American groups) may be required. This review process would require implementation of appropriate mitigation measures to minimize habitat disruptions during earthmoving activities, including scheduling limitations on excavation work, performance of short-term biological monitoring prior to, during, and after construction activities, and long-term biological monitoring and habitat restoration measures.

3.6.3.7 Cost

A summary of the costs is provided below.

Alternative 1111-S1: No Action

No costs are associated with Alternative 1111-S1.

Alternative 1111-S2: Institutional Controls

The total cost of Alternative 1111-S2 is estimated to be $295,000. This cost covers the administrative costs for implementation of use restrictions and future inspection/reporting costs of the site surface, annual reporting costs, and 5-year review with subsequent reporting. If institutional controls were implemented, there would be indirect costs

associated with the Base not being able to use the property for training and other purposes. This potential loss of land use is not quantified in this document, but is considered as a factor in evaluating implementability of institutional controls as a remedial alternative. A cost estimate, including inspection/reporting costs, is provided in Appendix F2.

Alternative 1111-S3: Soil Excavation, Backfill, and Off-Base Disposal

The cost for Alternative 1111-S3 is estimated at $711,400. This cost includes the required equipment, materials, and labor to perform site preparation, including construction of the soil stockpile area; excavation, backfilling with clean soil, and stockpiling; on-Base pretreatment of all excavated soil to incorporate chemical stabilizer; confirmation sampling and laboratory analysis; waste characterization; transportation and disposal of contaminated soil at a California hazardous waste disposal facility; surveying; and site restoration. A breakdown of the cost estimate is provided in Appendix F2.

## 3.7 Comparative Analysis of Alternatives

This section provides a comparative evaluation of Alternatives 1111-S1 through 1111-S3 relative to the NCP criteria and discusses the relative advantages and disadvantages of the alternatives.

### 3.7.1 Overall Protection of Human Health and the Environment

Alternative 1111-S1 would leave contaminant concentrations in place that pose a potential threat for future human health exposure. Alternative 1111-S2 would control exposure pathways and would be protective of human health. Alternative 1111-S3 would protect human health through removal and disposal of impacted soils in an appropriate off-Base disposal facility.

### 3.7.2 Compliance With ARARs

Based on the screening-level ERA, Alternatives 1111-S1 and 1111-S2 would not comply with location-specific requirements of the Endangered Species Act and RCRA requirements for sites located within a floodplain. Alternative 1111-S3 would comply with ARARs for excavation, waste piles, transportation, and disposal. It is likely that Alternative 1111-S3 would also comply with action- and location-specific requirements of the Endangered Species Act, although coordination with the USFWS would be required. Alternative 1111-S3 would also comply with all RCRA location-specific requirements and with RCRA clean closure requirements.

### 3.7.3 Long-Term Effectiveness and Permanence

Alternative 1111-S1 is rated low for long-term effectiveness and permanence because no measures or controls are associated with this alternative. Alternative 1111-S2 would require long-term maintenance. Alternative 1111-S2 would provide a degree of long-term effectiveness through limiting exposure and site uses. Alternative 1111-S3 would provide the greatest degree of long-term effectiveness and permanence because it involves removal of the contaminated soils from the area and backfilling of the excavation with clean import soil. For Alternative 1111-S3, the measures and controls implemented would effectively reduce the potential for future human exposure, and no further actions (e.g. institutional controls) would be necessary.

### 3.7.4 Reduction of Mobility, Toxicity, or Volume Through Treatment

All three alternatives are rated low for this evaluation criterion because there is no reduction in toxicity, mobility, or volume through treatment for any of these alternatives.

### 3.7.5 Short-Term Effectiveness

This criterion is not rated for Alternative 1111-S1 because it does not involve any actions that would disturb the site. The short-term effectiveness of Alternative 1111-S2 is ranked high and is expected to be the greatest of the four alternatives. Minimal site activities are planned. The potential for short-term dust exposure exists during excavation and transportation to an off-Base disposal facility for Alternative 1111-S3. Alternative 1111-S3, which is ranked moderate, could result in short-term impacts to ecological receptors although impacts would be minimal if appropriate regulatory coordination occurs, including implementation of any required mitigation and monitoring measures during construction.

### 3.7.6 Implementability

This criterion is not rated for Alternative 1111-S1 because no activities would be conducted under this alternative. Alternatives 1111-S2 and 1111-S3 are readily implementable and involve commonly performed remedial operations. Alternative 1111-S2 is considered easier to implement because activities are largely administrative. However, given that the Base mission is to support training, any area with a land use restriction would limit that function and this potential loss of land use causes Alternative 1111-S2 to be rated moderate.

Excavation for Alternative 1111-S3 uses standard equipment and labor skills and is readily implementable. Alternative 1111-S3 is ranked high because all components of this alternative are readily implementable.

### 3.7.7 Cost

No cost is associated with Alternative 1111-S1. Alternative 1111-S2 is less expensive than Alternative 1111-S3, with an estimated cost of $295,000. Alternative 1111-S3 is the most expensive remedial alternative for Site 1111, at a cost of approximately $711,400.

### 3.7.8 Summary of Comparative Analysis

The results of the comparative analysis for Site 1111 soil are summarized below.

| Criteria | Alternative | | |
|---|---|---|---|
| | 1111-S1[a] | 1111-S2[b] | 1111-S3[c] |
| **Threshold Criteria** | | | |
| Overall Protection of Human Health and the Environment | No | No[d] | Yes |
| Compliance with ARARs | No | No | Yes |
| **Balancing Criteria** | | | |
| Long-Term Effectiveness and Permanence | Low | Low | High |
| Reduction of Toxicity, Mobility, or Volume by Treatment | Low | Low | Low |
| Short-Term Effectiveness | Not Rated | High | Moderate |
| Implementability | Not Rated | Moderate | High |

| | | | |
|---|---|---|---|
| Cost ($ million) | 0 | 0.30 | 0.71 |

[a] No Action
[b] Institutional Controls
[c] Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal
[d] Institutional controls would be protective of human health but not protective of ecological receptors

Alternative 1111-S1 does not meet ARARs and would not be protective of the environment. Alternative 1111-S1 also does not provide long-term effectiveness and permanence. No costs are associated with Alternative 1111-S1.

Alternative 1111-S2 would be protective of human health and groundwater through use restrictions but would not be protective of ecological receptors. The potential for longer term adverse ecological impacts is increased due to the site's vulnerability to flooding, which could mobilize or expose subsurface soil contamination that is not currently available for contact with ecological receptors.

Alternative 1111-S3 would be protective of human health and the environment, meet ARARs, and provide a high degree of long-term effectiveness and permanence. Alternative 1111-S3 has the highest ranking for implementability.

The cost to reduce the ecological risks and exposure pathways associated with site metals, with restricted land use, is estimated to be $295,000 for Alternative 1111-S2. To achieve a higher level of protectiveness and unrestricted future land use, Alternative 1111-S3 would require overall costs of approximately $711,400.

## 3.8 Development of Remedial Action Objectives for Groundwater

As discussed in Section 1, per the framework of CERCLA, NCP, and SARA, the RI/FS and subsequent remedial activities conducted at Site 1111 must comply with federal and state ARARs. The ARARs/TBC that potentially apply to Site 1111 Groundwater are discussed in detail in Appendix A. USEPA guidance (USEPA, 1988) requires that RAOs be developed during the initial phase of the FS and be used as the framework for developing the remedial alternatives. Sections 3.8 through 3.13 address the groundwater contamination at Site 1111 that might require remediation as indicated during the RI.

### 3.8.1 Chemicals of Concern in Groundwater

As discussed in Section 3.1.3.2, several VOCs, primarily chlorinated ethenes (PCE, TCE, *cis*-1,2-DCE) and ethanes have been detected in groundwater at Site 1111 at concentrations above MCLs. The highest VOC concentrations are observed in the source area, which includes the burn layer. The highest contaminant concentrations in soil are also observed in this area (Figure 3-2).

### 3.8.2 Exposure Routes/Receptors of Concern for Groundwater

The HHRA conducted for groundwater under the OU 5 RI (Parsons, 2004) used hypothetical adult domestic groundwater user, hypothetical child domestic groundwater user, on-Base adult domestic groundwater user, and on-Base child domestic groundwater user exposure scenarios to assess the risks to human receptors from contaminated groundwater. The risk assessment concluded that, based on the residential exposure scenario, hypothetical future residents could be exposed to contaminants via ingestion of COPCs during use of contaminated groundwater. Based

on maximum detected groundwater concentrations, risk and hazard estimates exceed the upper end of the USEPA risk range and target hazard index of one.

The nearest downgradient in-service Base production well, 10S/04W-07R02, is located 1,850 feet southwest of the site (Figure 3-1). Site 1111 is within the capture zone of this well (SWDIV, 1993). An upgradient groundwater production well, 10S/04W-07H02, is located 1,300 feet north of the site. Both wells are in service. Current analytical results and fate-and-transport analysis indicate that site contamination has not migrated, and is not projected to migrate, to the Base production wells.

### 3.8.3 Proposed Remedial Action Objectives and Remediation Goals for Groundwater

The following RAOs were developed for Site 1111 groundwater contamination to address the protection of human health and the environment:

- Minimize inhalation/dermal contact/ingestion of contaminated groundwater containing VOCs at concentration in excess of RGs. RGs are defined as background (not detectable), if achievable, or concentrations that are technically achievable at a reasonable cost, but not exceeding MCLs.
- Protect the beneficial uses and water-quality objectives of the lower Santa Margarita River basin.

Groundwater quality goals considered in the development of alternatives for this site include drinking water standards and background. Drinking water standards used include the more stringent of the federal and state MCLs, and, where those are unavailable, nonzero MCLGs and tap water PRGs. A value of 0.5 µg/L for the remedial COCs is considered as the background level to evaluate alternatives that involve cleanup to background. This value is consistent with DLRs for VOCs promulgated under CCR Title 22, Division 4, Chapter 15, Article 5.5. The evaluations of remedial alternatives for the site address the time estimated to achieve both MCLs and background levels.

## 3.9 Identification of General Response Actions for Groundwater

General Response Actions (GRAs) represent general classes of technologies that have common characteristics in the way they address the risk posed by contaminated groundwater (i.e., the RAOs). The following GRAs are considered for Site 1111:

- No Action: No further remedial action for the environmental media.
- Institutional Control: Use restrictions and/or groundwater monitoring but no active remediation of the contaminated media; includes the analysis of attenuation of contaminants via naturally occurring physical and biological processes.
- Containment: Primarily physical measures to restrict contaminant migration or waste movement.
- Groundwater Extraction: Removal of contaminated material from the contaminated media.
- Treatment (in situ and ex situ): Physical, chemical, and biological measures that reduce toxicity, mobility, or volume of a contaminant or waste by altering the physical or chemical properties of the contaminants and/or media.

- Disposal/Discharge: Placement of treated or untreated material in a temporary or permanent, preengineered, controlled environment that will restrict contaminant migration and, thus, eliminate exposure routes.

## 3.10 Identification and Screening of Technology Types and Process Options for Groundwater

The objective of this section is to identify remedial technologies and process options for application for groundwater remediation at Site 1111. This objective is accomplished using a variety of information including previous investigations, remedial actions at other sites, references developed by USEPA for application at NPL sites, USEPA computerized technology databases (ATTIC, Version 1.0, VISITT, Version 2.0, and CLU-IN), and standard engineering references.

For each GRA discussed above, several remedial technologies exist that are applicable to the type of groundwater contamination at Site 1111. The goal of the screening process is to evaluate a large number of these technologies to identify those that are technically feasible to implement under the site-specific conditions. In this step, both process options and entire technology types can be eliminated based on technical effectiveness and/or implementability considerations. Information on site characteristics and contaminant types and concentrations was used to eliminate technology types and process options that are neither applicable nor effectively implementable at the site.

The remedial technologies identified and evaluated in the previous feasibility studies performed for MCB Camp Pendleton and other IR sites, served as the starting point for the list of technology options evaluated in this FS report. These evaluations were revised as appropriate to reflect current site conditions and technology updates. In addition, any relevant new technologies were added to the evaluation. A summary of the technologies evaluated in this FS is presented below:

Figure 3-5 lists the GRAs for Site 1111 groundwater contamination, identifies the remedial technologies and process types for each response action, and presents a summary of the screening results for each technology and process. A brief description of the technologies and process options under each GRA is provided in the following sections, along with the rationale for keeping or eliminating each technology.

- Institutional Controls
  - Use Restrictions
  - Wellhead Treatment
  - Groundwater Monitoring
  - Monitored Natural Attenuation
  - Alternate Water Supply
- Containment
  - Vertical Barriers
  - Hydraulic Barriers
  - Subsurface Drains
- Groundwater Extraction
  - Extraction Wells
  - Well Points
  - Dual Phase Extraction
- Groundwater Discharge/Disposal
  - Surface Discharge
  - Treatment Plants/POTWs
  - Subsurface Discharge (Injection Wells)
- In Situ Physical Treatment
  - Air Sparging
  - In-Well Air Stripping
- In Situ Chemical Treatment
  - Chemical Oxidation
  - Permeable Reactive Barrier
- In Situ Chemical Treatment (con.)
  - Zero-Valent Iron Treatment in Source Area
- In Situ Biological Treatment
  - Enhanced Bioremediation
  - Phytoremediation
- Ex Situ Physical Treatment
  - Air Stripping
  - Liquid-Phase Carbon Adsorption
  - Membrane Separation
  - Flow Equalization
  - Sedimentation
  - Filtration
  - Liquid-Liquid Extraction
- Ex Situ Chemical Treatment
  - Ion Exchange
  - Chemical Precipitation
  - Oxidation - Reduction
  - Chemical Dechlorination
  - Coagulation/Flocculation
  - Coprecipitation
  - Ultraviolet (UV) Oxidation
- Ex Situ Biological Treatment
  - Fixed-Film Bioreactor
  - Suspended Growth Bioreactor

### 3.10.1 No Action

The no action response was retained for consideration during the development and analysis of alternatives as required by the NCP (40 CFR 300.430[e][6]). The no action response does not provide additional remediation, monitoring, or security at the sites to reduce potential risk to human health or the environment.

### 3.10.2 Institutional Controls

Institutional controls are actions taken to reduce or eliminate risks to public health and the environment by controlling exposure pathways rather than removing the contaminants or reducing their mobility, toxicity, or volume. Institutional controls may consist of physical restrictions, administrative restrictions, and/or monitoring of contaminants in groundwater. The institutional controls considered for Site 1111 include groundwater use restrictions, wellhead treatment, groundwater monitoring, MNA, and an alternate water supply.

#### 3.10.2.1 Use Restrictions

Physical restrictions may include the use of signs and/or security measures to limit or prevent future use of groundwater at the site. Administrative restrictions include legal or Base-directed restrictions on construction activities and prohibitions on drilling of water

wells and/or use of groundwater within the contaminated area. The aquifer in the general area of Site 1111 (i.e., the lower Santa Margarita River basin) is currently used as a drinking water supply for the Base. However, current analytical results and fate-and-transport analysis indicate that site contamination has not migrated, and is not projected to migrate, to the Base production wells. Restricting groundwater use in the contaminated plume is a viable option and was retained for further evaluation.

#### 3.10.2.2 Wellhead Treatment

This option involves treatment of groundwater produced from the lower Santa Margarita River basin before being discharged into the reservoir that is used to store groundwater. Although it does not provide complete remediation of groundwater in the vicinity of Site 1111, this option protects the receptors of groundwater in this area. Therefore, this option was retained for evaluation. The treatment technologies available for this option are addressed in Section 3.10.7.

#### 3.10.2.3 Groundwater Monitoring

Groundwater monitoring includes periodic sampling and analysis of groundwater from monitoring wells (either existing or new) strategically located to monitor plume conditions and the performance and progress of groundwater contaminant remediation. Groundwater monitoring plans are designed and tailored to address site-specific RAOs. The resulting data can be used in different ways, depending on the objectives, to demonstrate trends in contaminant concentrations, to monitor contaminant migration and compliance with regulatory requirements, to track the performance and effectiveness of the selected remedy, or to determine when remedial goals have been met. Long-term monitoring of groundwater is an integral component of any remedial action alternative for groundwater and is conducted throughout the entire duration of the remediation process.

Groundwater monitoring can be implemented alone, in conjunction with institutional controls, or as a component of other treatment or containment alternatives. This process option is retained for further consideration.

#### 3.10.2.4 Monitored Natural Attenuation

Monitored natural attenuation (MNA) is a management strategy that relies on the evaluation and application of natural subsurface processes such as biodegradation, dispersion, dilution, adsorption, volatilization, and abiotic (chemical) degradation of groundwater contaminants (USEPA, 1998). MNA relies on these processes to achieve site-specific RAOs within a time frame that is reasonable compared to that offered by other more active methods (USEPA, 1999). Long-term groundwater monitoring is the major component of MNA. Monitoring of other media (e.g., soil gas, pond surface water/sediments) may be necessary to determine possible impacts to potential receptors and contaminant migration. Effective application of MNA involves a properly designed monitoring network and clearly defined performance criteria based on site-specific RAOs. MNA objectives are met through routine evaluations of institutional controls and measurements of contaminant, geochemical, and hydrologic parameters.

The mechanisms for natural attenuation of groundwater contaminants include non-destructive processes (advection, dispersion, dilution from recharge, sorption, and volatilization) that act to reduce contaminant concentrations via dilution or transfer to another medium, and destructive processes (biodegradation and abiotic degradation) that reduce contaminant mass. Of these processes, biodegradation is the mechanism that most commonly occurs to transform subsurface contaminants into innocuous by-

products. During natural biodegradation, indigenous microorganisms reduce the total mass of contaminants in the subsurface without engineered enhancements. Patterns and rates of natural attenuation can vary markedly from site to site depending on governing physical and chemical processes.

The geochemical data suggest that limited natural attenuation of chlorinated solvents in Site 1111 groundwater may be occurring, as evident from the TCE degradation products (*cis*-1,2-DCE, *trans*-1,2-DCE, and 1,1-DCE) and methanogenic conditions at the site. However, the lack of fuel hydrocarbons and oxygen depletion, low TOC concentrations, and lack of ferrous iron or carbon dioxide production in groundwater indicate that reductive dechlorination is electron-donor-limited at the site. In general, the data do not suggest that the groundwater environment is strongly reducing (i.e., conditions favorable for the reductive dechlorination of chlorinated solvents). The VLEACH modeling results indicate that vadose zone contaminants in the source area (i.e., the burn area) at Site 1111 pose a continuous threat to groundwater, and the BIOCHLOR groundwater simulation indicates that a CAH plume would remain at a steady state indefinitely if the source area was not removed or treated (Parsons, 2004). Additional monitoring wells within the source area (i.e., a replacement for MW-03) would be required to implement this technology.

MNA offers several advantages over engineered treatment systems, including:

- Chemicals are permanently mineralized (broken down) to relatively harmless compounds in situ by destructive attenuation mechanisms. In comparison, ex situ treatment systems often merely transfer chemicals from one phase and medium to another.
- Current technologies that involve active groundwater extraction (i.e., pump-and-treat systems) are energy-intensive and generally not effective in reducing in situ residual contamination to acceptable site closure criteria in a timeframe that is significantly different than would occur by MNA alone.
- MNA is nonintrusive and allows full and continuing use of land surface infrastructure during remediation.
- Current engineered remedial technologies may pose a greater risk to potential receptors than MNA (e.g., contaminants may be transferred into another medium, or workers may become exposed to COCs during non-MNA remediation activities).
- MNA is generally less costly than conventional, engineered remedial technologies. With the exception of regular monitoring to verify MNA and occasional well maintenance, the passive nature of MNA minimizes O&M expenses.
- No contaminated media are extracted from the subsurface, so air and water treatment, discharge, and permitting issues are eliminated with MNA.

A potential disadvantage of MNA is that the timeframe for achieving RAOs may be unacceptably long, within the context of the current or desired future land use. In addition, biodegradation of highly chlorinated compounds (e.g., TCE) can produce daughter products that are relatively toxic (e.g., vinyl chloride).

MNA can be implemented alone, in conjunction with institutional controls, or as a component of other treatment or containment alternatives. This process option is retained for further consideration.

#### 3.10.2.5 Alternate Water Supply

This option involves providing the users of the affected groundwater with an alternate supply of water. This may be accomplished by connecting the affected users to a city water supply, or by installing new water supply wells in nonimpacted areas of the aquifer. Due to the relative isolation of the Base from nearby cities, connecting to a city water supply is not feasible. However, installing new supply wells is potentially applicable and this option was retained for evaluation.

### 3.10.3 Containment

Containment measures are often used to prevent or significantly reduce the migration of groundwater contaminants out of the established plume boundary or into water supply systems. Containment involves the placement of physical barriers to stop or slow the movement of contaminated groundwater. Different types and constructions of control/containment systems are available for various environments and applications. A combination of containment barriers may be used to provide for adequate isolation and control of the groundwater plume. The containment technologies screened for groundwater include vertical barriers, hydraulic barriers, and subsurface drains.

#### 3.10.3.1 Vertical Barriers

Vertical barriers are structures such as a slurry wall, grout curtain, sheet piling cutoff wall, or vibrating beam wall that are capable of limiting downgradient contaminant migration. Because of the low concentrations of VOCs in shallow groundwater and the depth of the aquifer's lower confining layer, vertical barriers are not considered to be practical for Site 1111. Therefore, this technology was not retained for further evaluation.

#### 3.10.3.2 Hydraulic Barriers

Groundwater pumping can be used effectively as a hydraulic barrier by lowering the groundwater levels (either piezometric levels or the water table) at the leading edge of the plume, to prevent downgradient migration of contaminants. Groundwater pumping can be used solely as a hydraulic barrier (without treatment), but is most often accompanied by some form of treatment of the extracted groundwater prior to discharge.

A key component of hydraulic barriers is a groundwater monitoring well network and sampling program designed to monitor the effectiveness of the containment system. In some situations, early warning monitoring wells located at designated sentry wells between drinking water supply wells and the contaminant plume can be used to trigger pumping. Based on the site conditions, the use of hydraulic barriers is technically feasible and implementable. However, the current and historical data indicate that there is no downgradient migration of chlorinated VOC groundwater contamination at Site 1111. Therefore, this technology was not retained for further evaluation.

#### 3.10.3.3 Subsurface Drains

Groundwater interceptor trenches can be constructed to intercept upgradient groundwater and transport it to a central area for treatment or proper disposal. Due to low VOC concentrations at Site 1111, however, this option was considered impractical for capturing the contaminated groundwater. Therefore, it was not retained for further evaluation.

### 3.10.4 Groundwater Extraction

Groundwater extraction techniques involve the active manipulation and management of groundwater to contain or remove a plume. The use of groundwater pumping for hydraulic containment is discussed in Section 3.10.3.2. Groundwater extraction technologies evaluated for Site 1111 include extraction wells, well points, and dual-phase extraction. The selection of the appropriate extraction technique depends upon the remedial objectives, depth of contamination, and the hydrologic and geologic characteristics of the aquifer.

#### 3.10.4.1 Extraction Wells

Extraction wells are installed within a groundwater plume to pump contaminated groundwater out to the ground surface for treatment or management. The appropriate location, depth, and well configuration is determined by the boundaries of the groundwater plume, the hydrogeologic characteristics of the aquifer, and the remedial objective of the pumping system. The extraction rate and location of the wells are optimized to minimize extraction of clean groundwater and reduce the time needed to remove the contaminated groundwater plume. Well design focuses on enhancing performance and increasing the lifetime of the wells and pumps. Contaminant mass removal occurs as contamination sorbed to soil gradually dissolves into groundwater and then the contaminated groundwater is extracted. The time needed to remove the contaminated groundwater plume is dependent on the permeability of the aquifer and on the rate that contaminants disassociate from soil. Information generated during the RI indicates that the high permeability of the aquifer at Site 1111 is suitable for the application of this technology. While extraction wells are a commonly used technology and may be considered technically feasible for Site 1111 based on the aquifer characteristics, the low levels of VOCs make this option impractical. Therefore, this technology was not retained for further evaluation.

#### 3.10.4.2 Well Points

A well point system is a matrix of driven wells connected to a single suction pump. Well points work best when the water to be extracted is within 20 feet of ground surface to be within suction limits. Well point systems are effective for construction dewatering purposes and are best used for localized dewatering in shallow low permeability zones. The normal capacity for a well point system is less than 20 gallons per minute (gpm). Although well points are potentially applicable for shallow groundwater tables as found at Site 1111, the aquifer thickness, high permeability, and scattered, widespread detections of low organic concentrations significantly limit the effectiveness of this technology. Therefore, it was eliminated from further consideration.

#### 3.10.4.3 Dual Phase Extraction

This technology uses a high vacuum system to remove various combinations of contaminated groundwater, separate-phase product and vapor-phase contamination from the subsurface. For dissolved organic groundwater contamination, such as at Site 1111, high vacuum liquid/vapor treatment systems are designed to remove contaminants from above and below the water table. The system lowers the water table around the well, exposing more of the formation and making contaminants in the newly exposed vadose zone accessible to vapor extraction, which can remove contaminants more efficiently than pump-and-treat. The extracted liquids and vapors are separated

and treated aboveground. This technology is most effectively used for low-permeability or heterogeneous formations. Therefore, it is not retained for further evaluation.

### 3.10.5 Groundwater Discharge/Disposal

After contaminated groundwater is brought to the ground surface, it must be discharged with or without treatment. Although no groundwater extraction options were retained (Section 10.4), possible disposal options are evaluated for Site 1111 in this section, including surface discharge, treatment plant, and injection wells. A discussion of these disposal options is provided in the event that groundwater extraction is considered part of a viable strategy in the future, or if significant quantities of water are removed as part of future field-scale testing in the future. The feasibility of these options depends, in part, on whether the extracted groundwater is pretreated prior to discharge. This section evaluates the feasibility of discharge options with and without treatment, but does not discuss treatment options. Ex situ treatment technologies are discussed in Section 3.10.7.

#### 3.10.5.1 Surface Discharge

This process option involves discharging to a designated surface water body on- or off-Base with or without treatment. Although a discharge permit may not be needed for on-Base surface discharges of untreated groundwater, substantive requirements would need to be met to ensure the protection of surface waters. Contaminant concentrations in Site 1111 groundwater exceed discharge criteria and, therefore, on-Base surface discharge of untreated groundwater is not feasible. The use of a reliable treatment method such as activated carbon could provide the necessary protection for discharge to a surface drainage. However, significant regulatory compliance issues and stringent water quality standards complicate this option and limit its feasibility.

The only off-Base surface water body near MCB Camp Pendleton suitable for surface discharge is the Pacific Ocean, located several miles away from the site. Certain standards (ARARs) must be met before groundwater could be discharged. In addition to the relatively far distance to the ocean, this option is impractical because the water must be treated prior to discharge. Therefore, because of distance, ARARs, and that no extraction options were retained, the off-Base surface discharge option is not retained for further evaluation.

#### 3.10.5.2 Discharge to Treatment Plant or Publicly Owned Treatment Works

This process option involves transferring the extracted groundwater, untreated, to an existing on-Base wastewater or sewage treatment plant. The capabilities of the on-Base wastewater treatment facility, located in the 22 Area, are limited to iron and manganese treatment. Chlorinated solvents in Site 1111 groundwater cannot be effectively removed. Discharge of treated groundwater to a sanitation sewer and then pumping it to the on-Base sewage treatment plant is considered to be technically feasible because of the relatively close proximity of the plant to the groundwater contamination at Site 1111.

Using the sewage treatment plant to receive the treated groundwater would eliminate significant regulatory restrictions (ARARs). However, the additional influent into the sewage treatment plant could place unacceptable loads on the plant capacity and may require significant capital upgrades to the plant. Adding above ground tanks to allow for temporary storage of the groundwater and then discharging to the Base plant at night (during low flow conditions) may reduce overall capital upgrades to the plant (i.e., flow equalization techniques). While this option for discharge of treated groundwater is

considered technically feasible, no extraction options were retained and therefore disposal of extracted groundwater is unnecessary and is not retained for further evaluation.

Discharging extracted groundwater to a POTW located off-Base is also not an option because the three POTW facilities in Oceanside close to MCB Camp Pendleton are limited to municipal sewage treatment and cannot effectively treat the chlorinated organics in Site 1111 groundwater. Therefore, because of these treatment limitations and because no extraction options were retained, the option to discharge untreated groundwater to an on-Base treatment plant or off-Base POTW is not retained for further evaluation.

3 10.5.3 Subsurface Discharge

Injection wells may be installed to introduce water from the ground surface into the aquifer, under controlled conditions, usually to alter the movement of the groundwater plume. Injection wells can be used to return groundwater to the subsurface. Injection wells may also be used in conjunction with extraction wells to recirculate water while natural attenuation or other in situ process reduces levels of contaminants. While the high permeability of the aquifer at Site 1111 makes the use of injection wells technically feasible, the low levels of VOCs in groundwater make this option impractical. Therefore, injection wells were not retained for further evaluation.

### 3.10.6 In Situ Treatment

The main advantage of in situ treatment is that it allows groundwater to be treated without being brought to the surface and results in significant cost savings. In situ treatment, however, generally requires more time, and there is less certainty about the uniformity of treatment because of the variability in aquifer characteristics and because the efficiency of the process is more difficult to verify.

In situ treatment includes both engineered and enhanced natural processes capable of destroying or immobilizing dissolved contamination in place. In some instances, compounds may break down into more toxic by-products, or regulated products may be introduced into the aquifer that may be mobilized in groundwater if no control techniques are used. To address this issue, in situ processes are typically performed above a low-permeability soil layer and with groundwater monitoring wells downgradient of the remediation area. In situ treatment is generally less expensive than ex situ treatment because it entails no cost for pumping, treating, and discharging of extracted groundwater. In situ treatment technologies evaluated for groundwater at Site 1111 fall into three broad groups: physical, chemical, and biological.

3.10.6.1 In Situ Physical Treatment

Physical treatment uses the physical properties of the contaminants or the contaminated medium to destroy or separate the contamination. Technologies in this group evaluated for Site 1111 include air sparging, in-well air stripping, and passive/reactive treatment walls.

3.10.6.1.1 Air Sparging/Soil Vapor Extraction

Air sparging is an in situ technology in which air is injected through a contaminated aquifer. Injected air traverses buoyantly in channels through the soil column, creating an underground stripper that removes contaminants by volatilization. Air may be injected through vertical or horizontal wells. This injected air helps to flush (bubble) the

contaminants up into the unsaturated zone where a soil vapor extraction (SVE) system is usually implemented in conjunction to remove the generated vapor phase contamination. Air sparging can also enhance aerobic biodegradation of the less chlorinated ethenes by increasing the oxygen content of the saturated zone. Air sparging has a medium to long duration that generally lasts up to a few years. The technology is well suited to treat VOC contamination in highly permeable, coarse-grained, relatively homogeneous aquifer material in which a uniform distribution of air bubbles is possible.

Air sparging has been demonstrated at numerous sites, but is not potentially applicable to Site 1111 groundwater because of the low concentrations of VOCs in groundwater. Therefore, neither horizontal nor vertical air sparging are retained for further evaluation.

#### 3.10.6.1.2 In-Well Air Stripping

In-well stripping works on the same principle as air stripping. Air is injected into a double screened well, using a diffuser to create a stream of fine bubbles. The rising bubbles create an airlift pump that lifts the water in the well and forces it out the upper screen. Contaminated groundwater is simultaneously drawn into the lower screen, which creates a hydraulic circulation pattern that allows continuous cycling of groundwater. Once in the well, some of the VOCs in the contaminated groundwater are transferred from the dissolved phase to the vapor phase by the air bubbles. The contaminated air rises in the well to the water surface where vapors are drawn off and treated by an SVE system. The SVE system also collects vapors from the vadose zone surrounding the well. As groundwater circulates through the treatment system in situ, contaminant concentrations are gradually reduced through multiple cycles to achieve the desired cleanup level. Because of the low level of VOCs present in Site 1111 groundwater, in-well air stripping is a technology that is not potentially applicable and is not retained for further evaluation.

### 3.10.6.2 In Situ Chemical Treatment

Chemical treatment uses the chemical properties of the contaminants or contaminated media to destroy the contaminants by converting them to innocuous compounds commonly found in nature. Chemical oxidation, permeable reactive barriers, and chemical reduction using zero-valent iron in the source zone were the in situ chemical treatment process options evaluated for Site 1111. These innovative technologies are being widely tested to evaluate their effectiveness for in situ remediation of organic contamination.

#### 3.10.6.2.1 Chemical Oxidation

In situ chemical oxidation involves the injection of chemical oxidants into the groundwater aquifer to react with and destroy the contaminants. The typical oxidants used in this process are Fenton's reagent (hydrogen peroxide [$H_2O_2$] combined with soluble iron), potassium permanganate ($KMnO_4$), and ozone ($O_3$). The appropriateness of this technology at a site depends on matching the oxidant and delivery system to the site contaminants, geochemistry, and hydrogeology (Siegrist et al., 2001).

While in situ chemical oxidation can effectively destroy groundwater contaminants, the oxidant is generally not selective and therefore may preferentially oxidize other constituents in soil and groundwater instead of the groundwater contaminants. Although TOC concentrations in Site 1111 groundwater are relatively low, there is likely significant organic carbon within the burn area soils, which would also react with injected oxidants and reduce the efficiency of chemical oxidation to remove the COCs. Also, in situ

chemical oxidation treatment is not applicable because there is no well-defined plume at the site and VOC concentrations are generally too low for significant reductions to occur through treatment. Therefore, in situ chemical oxidation is not retained for further evaluation for Site 1111 groundwater.

3.10.6.2.2 Permeable Reactive Barrier

This technology is based on vertical barriers that are placed in the path of a contaminant plume as discussed in Section 3.10.3.1. A passive treatment wall is permeable to uncontaminated water, allowing it to continue its natural course through the flow system while removing or degrading the contaminants as contaminated water moves through the wall. A permeable reactive barrier (PRB) wall consists of a subsurface groundwater treatment zone that is filled with reactive media. The most typical configuration and type of PRB is a downgradient trench that is filled with zero-valent iron (ZVI) for reductive dechlorination of contaminants, including TCE. The PRB wall is installed below the ground surface and across the flow path of a contaminant plume, allowing the contaminants to be treated while the groundwater plume passively moves through the wall. The PRB technology is not applicable for Site 1111 because VOC concentrations are generally too low for significant reductions to occur through treatment. Therefore, this technology option is not retained for further evaluation.

3.10.6.2.3 Zero-Valent Iron Permeable Reactive Barrier

ZVI may also be emplaced within the source area or core of a plume for in-plume treatment. However, ZVI is not applicable at this site because VOC concentrations are generally too low for significant reductions to occur through treatment. Therefore, this technology option has not been retained for further evaluation.

3.10.6.3 In Situ Biological Treatment

In situ bioremediation techniques are destruction techniques directed toward stimulating microorganisms in the subsurface to grow and use the contaminants as a food and energy source by creating a favorable environment for the microorganisms. Generally this means providing some combination of oxygen, nutrients, and moisture, and controlling the temperature and pH. Contaminants are destroyed and little to no residual treatment is required.

The in situ bioremediation techniques evaluated for the Site 1111 VOC plume include enhanced bioremediation and phytoremediation.

3.10.6.3.1 Enhanced Bioremediation

Bioremediation describes the destruction of groundwater contaminants by biologically mediated processes. Enhanced bioremediation utilizes addition of substrate, reagents, or microorganisms into the subsurface to accelerate the natural biodegradation processes. Bioremediation can occur under aerobic (oxygenated) or anaerobic (lacking oxygen) conditions; however, anaerobic conditions favor the biological degradation of TCE and other highly chlorinated CAHs through anaerobic reductive dechlorination. Less chlorinated CAHs (e.g., vinyl chloride) may be degraded under either aerobic or highly anaerobic (e.g., sulfate-reducing, methanogenic) conditions. The addition of an organic substrate to an aquifer has been demonstrated to stimulate microbial growth and development at many sites. The results of these injections have been observed to create an anaerobic environment in which rates of anaerobic degradation of CAHs may be increased. During enhanced bioremediation, degradation mechanisms may include

direct (metabolic) anaerobic, cometabolic anaerobic, or abiotic reductive dechlorination (AFCEE et al., 2004).

Enhanced bioremediation by reductive dechlorination can be promoted by adding organic substrate (i.e., electron donor) to the subsurface, which lowers the oxygen/reduction potential and promotes the use of CAH compounds as electron acceptors (dechlorination). Although a variety of substrate materials can and have been introduced to the subsurface for stimulating reductive dechlorination, for Site 1111 the injectable substrates are not applicable because there is no well-defined plume and VOC concentrations are generally too low for significant reductions to occur through treatment. However, the addition of solid substrates (such as mulch, compost, or chitin) can be considered in conjunction with source area soil excavation and removal. Backfilling of the soil excavation with (for example) bark mulch could result in the placement of organic material in direct contact with groundwater, resulting in a slow release of organic substrate in the groundwater near the source area. This would promote a more reducing subsurface environment, which would likely lead to higher rates of biological destruction of groundwater contaminants, including TCE. Therefore, this technology is retained for further evaluation.

3.10.6.3.2 Phytoremediation

Phytoremediation is an emerging technology that uses plants and their associated rhizospheric (root zone) microorganisms to remove, degrade, or contain chemical contaminants located in soil, sediment, or groundwater. Newer methods of phytoremediation have been able to use trees for the dual purpose of direct treatment of contaminants in the aquifer and as pumping mechanisms to control groundwater flow. Research has indicated that plants can be used to treat most classes of compounds, including chlorinated solvents. Plant species are selected for phytoremediation based on their potential to evapotranspirate groundwater, the degradative enzymes they produce, their growth rate and yield, the depth of their root zone, and their ability to bioaccumulate contaminants. Phytoremediation can only work at sites well-suited for plant growth where the contaminants present are within the plant root zone and not too deep, at concentrations that are not toxic to the plants. Based on the shallow depth to groundwater, the nature of the contamination, and the rural area overlying the plume, this technology is potentially applicable for addressing the groundwater contamination at Site 1111. Therefore, it is retained for further consideration.

### 3.10.7 Ex Situ Treatment

The main advantage of ex situ treatment is that it generally requires shorter time periods, and there is more certainty about the uniformity of treatment because of the ability to monitor and continuously mix the groundwater. Ex situ treatment, however, requires pumping of groundwater above the ground surface, leading to increased costs and engineering for treatment equipment, permitting, and material handling. Although no groundwater extraction options were retained (Section 3.10.4), possible ex situ treatment options are evaluated for Site 1111 in this section. A discussion of these treatment options is provided in the event that groundwater extraction is considered part of a viable strategy in the future, or if significant quantities of water are removed as part of future field-scale testing in the future. Ex situ treatment technologies that were evaluated for groundwater at Site 1111 fall into three broad groups: physical, chemical, and biological.

#### 3.10.7.1 Physical Treatment

Physical treatment uses the physical properties of the contaminants or the contaminated medium to separate, or contain, the contamination. While no extraction options were retained and therefore treatment of extracted groundwater would not be necessary, possible physical treatment technologies were evaluated for Site 1111 including air stripping, adsorption, membrane separation, flow equalization, sedimentation, filtration, and liquid/liquid extraction.

##### 3.10.7.1.1 Air Stripping

Air stripping is a full-scale technology in which VOCs are partitioned from extracted groundwater by greatly increasing the surface area of the contaminated groundwater exposed to air. Air stripping involves the mass transfer of volatile contaminants from water to air. For groundwater remediation, this process is typically conducted in a packed tower or aeration tank. The typical packed tower air stripper includes a spray nozzle at the top of the tower to distribute contaminated water over the packing in the column, a fan to force air countercurrent to the water flow, and a sump at the bottom of the tower to collect decontaminated groundwater. Aeration tanks strip volatile compounds by bubbling air into a tank through which contaminated water flows. A forced air blower and a distribution manifold are designed to ensure air-water contact without the need for any packing materials. Aeration tanks may include a series of shallow trays. An air emission control and treatment system (e.g., activated carbon, catalytic oxidizers, or thermal oxidizers) is used for both towers and tanks to capture and destroy the contaminated air. Several vendors offer these technologies as either skid-mounted units or permanent installations.

Air stripping is most effective for VOCs with Henry's Law constants greater than 0.01 atm-$m^3$/mol such as TCE, DCE, and other chlorinated VOCs. The eventual duration of cleanup using an air stripping system may be tens of years and depends on the capture of the entire plume from groundwater. While air stripping is potentially applicable for the low concentrations of VOCs in the groundwater at Site 1111, no extraction options were retained and therefore treatment of extracted groundwater in unnecessary and air stripping is not retained for further evaluation.

##### 3.10.7.1.2 Liquid-Phase Carbon Adsorption

Liquid-phase carbon adsorption is a full-scale technology that involves pumping groundwater through a series of canister or columns containing activated carbon to which dissolved organic contaminants adsorb. Periodic replacement or regeneration of saturated carbon is required when contaminant concentrations in the effluent exceeds a certain level. The carbon can be regenerated in place, removed and regenerated at an off-site facility, or removed, and disposed of. Pretreatment for removal of suspended solids from streams to be treated is an important design consideration to maximize the life of the carbon units and minimize backwashing downtime.

Carbon adsorption systems can be deployed rapidly, and contaminant removal efficiencies are high. Carbon adsorption is particularly effective for polishing water discharges from other remedial technologies to attain regulatory compliance. Limited effectiveness may be achieved for halogenated hydrocarbons. While carbon adsorption is potentially applicable to treat the low concentrations of VOCs in the groundwater at Site 1111, no extraction options were retained and therefore treatment of extracted groundwater is unnecessary and carbon absorption is not retained for further evaluation.

3.10.7.1.3 Membrane Separation

In membrane separation technologies, semipermeable membranes separate certain contaminants from a wastewater stream. These technologies do not destroy or alter the chemical or physical state of a contaminant; instead, they generate a clean stream and a reject stream in which contaminants that could not pass through the membrane are concentrated. The reject stream may need further treatment before disposal. Multiple units may be used in series to provide further concentration of the waste stream. In contrast to media filters, flow is typically tangential to the membrane surface and, as a result, a continuous flushing is induced to minimize plugging of the membrane. Major process designs for these technologies include ultrafiltration, distillation, and reverse osmosis. Ultrafiltration is ineffective for removing VOCs and inorganics from groundwater because the molecules of these compounds are too small to be retained by the membranes. Dialysis and reverse osmosis would not be appropriate for removing the low concentrations of chlorinated VOCs in the groundwater at Site 1111 because they are O&M and capital intensive, and may require multiple staging to achieve the desired goals, which may further increase costs. Therefore, membrane separation was not retained for further consideration.

3.10.7.1.4 Flow Equalization

Equalization is a starting point for many treatment processes to provide for a waste stream of uniform strength, consistency, and flow. The equalization process may allow interaction between various groundwater sources, thereby producing a degree of equalization without additional chemical treatment. This option is useful after extraction of groundwater and prior to treatment. This option does not directly address the VOC contamination in groundwater, but it is potentially applicable as a support technology. However, no extraction options were retained and therefore this technology is not retained for further evaluation.

3.10.7.1.5 Sedimentation

Sedimentation is a process that relies on gravity to remove suspended solids in an aqueous stream. It can be performed as either a batch or continuous process in lined impoundments, conventional settling basins, clarifiers, and high-rate gravity settlers. It is commonly applied to large volume aqueous wastes with high-suspended solids loading. Sedimentation may be required as a pretreatment step for chemical processes, but it is not commonly applied to small-scale groundwater remediation applications. This option does not directly address the VOC contamination in groundwater, but it is potentially applicable as a support technology. However, due to the large space requirements generally required for sedimentation compared to alternative separation alternatives (i.e., filtration), sedimentation is not retained for further evaluation.

3.10.7.1.6 Filtration

This technology involves removing suspended solids from solution by forcing the fluid through a porous medium. Common types of filters include sand, bag, membrane, or bed filters with various media. As the water-solids mixture passes through the porous media, the solid particles become trapped. Filtration may be needed to reduce the suspended solids content in groundwater to optimize the efficiency of the treatment system. This option does not directly address the VOC contamination in groundwater, but it is potentially applicable as a support technology. However, no extraction options were retained and therefore this technology is not retained for further evaluation.

3.10.7.1.7 Liquid/Liquid Extraction

Liquid/liquid extraction is the separation of constituents from a liquid solution by contact with another immiscible liquid in which the constituents are more soluble. Liquid/liquid extraction systems range from simple-stage mixer settlers to elaborate multistage extraction columns, run in a cross current, or more commonly, in a countercurrent mode. This technology is effective in treating water with high organic contamination levels. Considering the low VOC concentrations in the Site 1111 groundwater, this technology is not retained for further consideration.

3.10.7.2 Chemical Treatment

Chemical treatment uses the chemical properties of the contaminants or the contaminated medium to destroy (i.e., chemically convert) the contamination. While no extraction options were retained and therefore treatment of extracted groundwater would not be necessary, possible chemical treatment technologies were considered for Site 1111 including ion exchange, chemical precipitation, oxidation-reduction, chemical dechlorination, coagulation/flocculation, coprecipitation, and UV/chemical oxidation.

3.10.7.2.1 Ion Exchange

This treatment technology uses natural or synthetic inorganic microcrystalline structures, such as zeolites, and synthetic organic ion-exchange resins (Perry and Chilton, 1973) to exchange less desirable ions in the solution for the more desirable ions on the resin. The ion-exchange process is reversible, and the driving force for the exchange of ions is a function of the equilibrium governed by the relative insolubilities of the salts formed in the exchange process. Ion-exchange technology is not viable for VOCs; therefore, it is not retained for further evaluation.

3.10.7.2.2 Chemical Precipitation

This technology turns a dissolved ionic contaminant into an insoluble phase, which can then be removed or recovered. Several methods can induce precipitation in a solution. Chemicals also may be added to cause a shift in equilibrium, resulting in precipitation or coalescence. Chemical precipitation is not viable for VOCs; therefore, it is not retained for further evaluation.

3.10.7.2.3 Oxidation-Reduction

In chemical oxidation-reduction reactions, the oxidation state of the treated compound is raised or lowered by chemical addition. Considering that the organic contamination primarily includes relatively low concentrations of chlorinated VOCs in the Site 1111 groundwater, this technology is not retained for further consideration.

3.10.7.2.4 Chemical Dechlorination

Chemical dechlorination involves chemical reactions using catalysis, reduction, or oxidation to dehalogenate certain classes of chlorinated solvents. This technology is not retained for further consideration on the account of the low VOC concentrations.

3.10.7.2.5 Coagulation/Flocculation

Coagulation/flocculation involves the controlled addition of chemical reagents (e.g., alum and polymers) to create a suspension of fine particles and transform the suspension of particles into flocculents of coagulated material of larger particles. The flocculents may be easily separated by gravity, thickening, skimming, filtration, or centrifugation. Coagulation/flocculation is not an effective treatment method for the VOCs found in the

contaminated groundwater at Site 1111. While this technology is not considered further as a primary treatment technology, it could be incorporated as a potential support action. However, due to the large space requirements generally required for coagulation/flocculation, this technology is not retained for further evaluation.

3.10.7.2.6 Coprecipitation

Coprecipitation occurs when precipitation of an ionic compound is promoted by precipitation of a heavy metal in the wastewater. Coprecipitation is ineffective for removing VOCs from groundwater, and thus, is not retained for further consideration.

3.10.7.2.7 Ultraviolet Oxidation

UV oxidation is a destruction process that oxidizes organic contaminants in groundwater by the addition of strong oxidizers and irradiation with UV light. Oxidation of target contaminants is caused by direct reaction with oxidizers, UV photolysis, and through the synergistic action of UV light, in combination with ozone ($O_3$) and/or hydrogen peroxide ($H_2O_2$). If complete mineralization is achieved, the final products of oxidation are carbon dioxide ($CO_2$), water, and salts. A wide variety of organic contaminants, including chlorinated solvents, are susceptible to destruction by UV oxidation. However, due to the low VOC concentrations measured at the site, this technology is not retained for further evaluation.

3.10.7.3 Biological Treatment

While no extraction options were retained and therefore treatment of extracted groundwater would not be necessary, ex situ biological treatment was still evaluated for Site 1111. In ex situ biological treatment, contaminants in extracted groundwater are brought into contact with microorganisms in bioreactors. Bioreactors involve the use of a material to which the microorganisms adhere and grow. There are two major types of bioreactors: fixed-film and suspended growth. In fixed-film bioreactors, such as rotating biological contractors and trickling filters, microorganisms are established on an inert support matrix. In suspended growth bioreactors (e.g., activated sludge, fluidized beds, or sequencing batch reactors), contaminated groundwater is circulated in an aeration basin in which a microbial population aerobically degrades the organic matter.

The dilute nature of contaminated groundwater in general, and the very low concentrations of VOCs in Site 1111 groundwater in particular, are unlikely to support an adequate microbial population density for this technology to be effective under the site conditions. Therefore, ex situ biological treatment was not retained for further evaluation.

## 3.11 Evaluation of Technology Process Options

The next step in developing and screening alternatives involves an evaluation of the technologies and process options remaining from the initial technology screening. Technologies and process options judged to be potentially viable in the previous section for application to Site 1111 groundwater are reviewed according to three criteria: effectiveness, implementability, and cost. These criteria are briefly discussed below.

- **Effectiveness.** The effectiveness evaluation focuses on the following elements:
  - Potential effectiveness of process options for handling the estimated areas or volumes of media and meeting the RGs identified in the RAOs

- Potential impacts to human health and the environment during the construction and implementation phase
- Reliability and proven effectiveness of the process with respect to the contaminants and conditions at the site

- **Implementability.** The initial technology screening eliminated technology types or process options that were clearly ineffective or unworkable at the site. This evaluation addresses both the technical and institutional feasibility of implementing each process including the following institutional aspects:
  - Ability to obtain necessary permits and rights-of-way for off-site actions
  - Availability of necessary equipment and skilled workers to implement the technology
  - Availability (including capacity) of treatment, storage, and disposal services
- **Cost.** Cost plays a limited role in the screening of technologies at this phase. Relative capital and O&M costs are considered rather than absolute costs. For this evaluation, the cost analysis is based on engineering judgment. Each technique is evaluated as to whether costs are low, moderate, or high relative to other process options in the same technology type. The greatest cost consequences in site remediation are usually associated with the degree to which different technology types are used. Using different process options within a technology type usually has a less significant effect on cost than the use of different technology types. A technology process option can be eliminated on the basis of costs only if other process options within the same technology type are comparably effective and implementable but have a much lower cost.

Figure 3-6 lists all the technologies and process options that passed the initial screening in the previous section. Based on the above criteria, the process options were evaluated relative to other processes within the same technology type to select a representative process option to be included in a remedial alternative. At this stage of the FS, the major focus is on the effectiveness of each option; implementability and cost are of lesser importance. Each criterion is rated as low, moderate, or high relative to the technologies within the same process option. The results of the evaluation are discussed in the following sections and are summarized in Figure 3-6.

### 3.11.1 No Action

The evaluation of the no action option for groundwater is summarized below:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Although contaminants would remain in the groundwater, concentrations would decrease over time due to natural attenuation. The effectiveness of the no action option is rated low because groundwater use would be unrestricted and monitoring would not be conducted to evaluate the process of natural attenuation. | Low |
| Implementability | No equipment, skilled workers, or permits are required for the no-action option. | High |
| Cost | No cost is associated with no action. | High |

The no action option is retained for incorporation into remedial action alternatives, as required by the NCP, and will be used as a baseline for comparison of other options.

### 3.11.2 Institutional Controls

Use restrictions, wellhead treatment, groundwater monitoring, and MNA were retained as process options for this GRA and are evaluated below.

#### 3.11.2.1 Use Restriction

This option involves restricting the use of groundwater from within the contaminated groundwater plume near Site 1111 with land-use restrictions. The evaluation of this option is summarized below:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Although contaminants would remain in the groundwater, concentrations would decrease over time due to natural attenuation. This option would protect human health by limiting access to groundwater. | Low to Moderate |
| Implementability | The Base would implement restrictions for on-Base property use; specifically, that groundwater in the area impacted by the contaminants from Site 1111 would not be used for drinking water. | High |
| Cost | Costs associated with this option include minimal administrative costs. | High |

Based on the high ratings for implementability and cost, use restriction is retained for incorporation into the remedial action alternatives.

#### 3.11.2.2 Wellhead Treatment

This option would allow for continued production of groundwater from production wells currently serving the lower Santa Margarita River basin that could be impacted by contaminants from Site 1111. A treatment unit would be installed, operated, and maintained at the affected production wells. The evaluation of this option is summarized below:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | The effectiveness of this option is rated low because contamination has not been detected in the production wells and is not predicted to migrate to the production wells. | Low |
| Implementability | Many water treatment units are available commercially. The implementability of different treatment units is addressed in Section 3.11.7. | High |
| Cost | Costs associated with this option include purchase, installation, and periodic maintenance of the treatment unit. The costs for this option would be significantly higher due to the higher pumping rates required from the groundwater production wells compared to rates that would be expected from a treatment system. | Low |

Based on its low ratings for effectiveness and cost, wellhead treatment is not retained for further evaluation. Wellhead treatment could be considered as a contingency option if contamination reaches the production well after the selected alternative is implemented.

3.11.2.3 Groundwater Monitoring

This option involves the use of the existing monitoring well network and/or the installation of new wells to monitor the groundwater plume. The evaluation of this option is summarized as follows:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Groundwater monitoring is an effective, reliable, and proven technology that is an integral component of any remedial action. The potential impact on human health and the environment from implementation of groundwater monitoring is negligible. This option is effective for monitoring plume size and concentrations and for early warning of contaminant migration. | Moderate |
| Implementability | A monitoring network already exists in the general vicinity of Site 1111. If additional wells are needed, they can be installed quickly; equipment and services are readily available. This option involves selection of monitoring locations based on the predicted plume movement. | High |
| Cost | Costs include well construction, well maintenance, sampling and analysis, data evaluation, and reporting. | Moderate to High |

Based on the high rating in implementability, and the moderate effectiveness and cost of this option, groundwater monitoring is retained for use in conjunction with other remedial options.

3.11.2.4 Monitored Natural Attenuation

This option involves using the existing monitoring well network and/or installing new wells to monitor the continued effectiveness of natural attenuation and to track the movement of the groundwater plume. The study of the contaminant concentrations is used to determine the level of natural attenuation occurring in the subsurface. Long-term monitoring would be used to confirm continued degradation of the contamination plume. The evaluation of this option is summarized as follows:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | MNA is an effective and proven technology that can be implemented alone or as a strategic component of the overall remedy. There is evidence of biodegradation already occurring at the site. This option involves strategic selection of monitoring well locations based on the predicted groundwater flowpaths, plume attenuation rates, and location of potential receptors. The potential impact on human health and the environment from implementation of MNA is negligible. If implemented alone, MNA is a long-term remedy; therefore, its effectiveness is rated as moderate. | Moderate |

| Criterion | Evaluation | Rating |
|---|---|---|
| Implementability | MNA is data driven. Effective implementation requires a properly designed groundwater monitoring network and sampling and analysis plan, and clearly defined performance criteria based on site-specific RAOs. The existing groundwater monitoring well network at Site 1111 can be easily adapted to satisfy MNA requirements. Needed additional wells can be installed quickly; equipment and services are readily available. | High |
| Cost | Costs include well construction, well maintenance, groundwater sampling and analysis for measurement of contaminant, geochemical, and hydrologic parameters, routine evaluation of institutional controls, data evaluation, and reporting. | Moderate |

The low concentrations of contaminants complicate distinguishing changes in geochemical parameters due to reductive dechlorination. However, modeling of the site plume indicates that biodegradation is already playing an important role in maintaining a stable plume. Also, the historical presence of daughter products in the source zone provides evidence that biodegradation is naturally feasible. Based on the high rating in implementability, and the moderate effectiveness and cost of this option, MNA is retained for further evaluation for use as a stand-alone technology or in conjunction with other remedial options.

### 3.11.3 Containment

No containment process options were retained from the initial screening.

### 3.11.4 Groundwater Extraction

No removal process options were retained from the initial screening.

### 3.11.5 Groundwater Discharge / Disposal

Because hydraulic containment and groundwater extraction were not retained for further consideration as remedial alternatives, there is no need for groundwater discharge or disposal options to be evaluated further.

### 3.11.6 In Situ Treatment

Enhanced bioremediation and phytoremediation were the only in situ groundwater treatment processes retained after the initial screening of technologies phase. These process options are further evaluated below.

#### 3.11.6.1 Enhanced Bioremediation

The evaluation of this process option is summarized below:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | The site appears conducive to anaerobic dechlorination. Addition of carbon sources should effectively accelerate natural attenuation timeframes. | Moderate |
| Implementability | Materials and equipment for application of this technology via injection points are readily available. | High |
| Cost | Major cost components include the capital cost of materials and groundwater monitoring | Moderate |

There is evidence that the site is conducive to biodegradation. Site data indicate an electron-donor-limited environment with low TOC values, and hence the addition of a carbon source would accelerate the bioremediation processes already present. Due to its moderate effectiveness and high implementability, this option is retained for incorporation into the remedial action alternatives.

3.11.6.2 Phytoremediation

The evaluation of this process option is summarized below:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | New vegetation would unlikely provide additional benefit beyond that what is being achieved by existing vegetation in maintaining a stable plume. Due to uncertainties in root uptake, growth rate, and field data, the overall effectiveness of planting new trees is likely to vary. Furthermore, plants tend to remove contaminants only from the top several feet of the aquifer. | Low to Moderate |
| Implementability | Readily implementable, although ecological factors would need to be considered in the types and placement of trees. However, non-native species with irrigation would be introduced into a sensitive ecological habitat. | Moderate |
| Cost | Major cost components include the capital cost of trees, excavating trenches, irrigation, and groundwater monitoring. | Moderate |

Addition of new vegetation would be detrimental, as the introduction of non-native species with irrigation would disrupt the sensitive ecological habitat and achieve little additional benefit. However, existing site vegetation may already be contributing to maintaining a stable plume. From this perspective, phytoremediation is retained for use in conjunction with other remedial options.

### 3.11.7 Ex Situ Treatment

No ex situ treatment options were retained from the initial screening.

### 3.11.8 Summary of Process Option Selection

The selection of process options for remediation of groundwater at Site 1111 are summarized below:

- The no action response is retained as required by the NCP.

- Use restrictions, long-term groundwater monitoring, and MNA are selected as institutional controls. Wellhead treatment could be considered as a contingency option if contamination reaches a production well.
- Enhanced bioremediation is retained as the in situ treatment process option.

The selected process options were retained for further consideration in developing remedial alternatives for Site 1111 groundwater. Different combinations of these process options are assembled to form sitewide remedial alternatives. Not all of the selected process options are included in an alternative. Some of the process options that are not being carried forward to the next phase at this time could be reconsidered during the design phase, assuming that the evaluation criteria are satisfied to a similar degree. The process options actually used to implement the design may not be selected until the remedial design phase.

## 3.12 Development and Detailed Analysis of Alternatives

Guidance for the development of remedial alternatives for Site 1111 groundwater was obtained from the following sources:

- 40 CFR 300 (NCP)
- Section 121 of SARA
- Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, 1988)
- Navy/Marine Corps Installation Restoration Manual (US Navy, 1992)

As required by the NCP and recommended by USEPA guidance (1988), acceptable engineering practices that relate to site-specific conditions were considered during development of the remedial action alternatives. For Site 1111, the media of concern addressed by this FS is groundwater. The remedial alternatives for Site 1111 groundwater were developed to satisfy the requirements of 40 CFR 00.430(e), which specifies that alternatives be developed to include no action, institutional controls, little or no treatment, and those that reduce the toxicity, mobility, or volume of contaminants.

Alternatives were developed to address the remedial COCs. Figures 5-12 to 5-14 in Appendix B2 summarize detectable contaminant concentrations in site groundwater samples. As discussed in Section 3.1.4, about 99 percent of the total VOC mass in the source area (78 kg.) is present in the vadose zone. The total mass of PCE and TCE in the dissolved plume, estimated at 0.4 kg, represents about 84 percent of the VOC mass present in the saturated zone (i.e., the remaining 1 percent of the total VOC mass). The BIOCHLOR evaluations indicate that the CAH plume is at a steady state, with PCE and TCE concentrations above MCLs reaching a maximum distance of 200 feet downgradient of the source, and the leading edge of the plume (i.e., above detectable levels, greater than 0.5 µg/L) extending to about 350 to 400 feet. The VOC mass in the source area provides an on-going source of VOCs to groundwater. If the source is not removed, the CAH plume would be expected to remain at a steady state for a long time.

### 3.12.1 Overview of the Detailed Analysis and the Nine NCP Evaluation Criteria

An overview of the detailed analysis process and the nine NCP evaluation criteria is presented in Section 1.6.

### 3.12.2 Description of Remedial Action Alternatives

The following four alternatives were developed to address the remediation of contaminated groundwater at Site 1111:

- Alternative 1111-G1: No Action
- Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3
- Alternative 1111-G3: Monitored Natural Attenuation with Alternative 1111-G2
- Alternative 1111-G4: Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3

#### 3.12.2.1 Alternative 1111-G1: No Action

Under the no action alternative, no remedial actions of any kind would be undertaken. The NCP requires that a no action alternative be retained for detailed evaluation as a baseline against which the other alternatives are compared. Existing monitoring wells would be secured and locked to prevent illegal disposal or tampering. No remediation or sampling of the groundwater would be conducted. No cost is associated with this alternative.

Natural attenuation processes would continue to degrade contaminants; however, there would be no groundwater monitoring data collected to document and demonstrate that the plume is not migrating. Since no additional groundwater monitoring data would be collected, there is some uncertainty regarding the future migration of groundwater contaminants. However, minimal migration of the plume is likely since the plume is expected to remain stable (Parsons, 2004).

#### 3.12.2.2 Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3

This alternative involves soil source removal (Alternative 1111-S3) followed by institutional controls and long-term groundwater monitoring, and relies on effective implementation of administrative control measures. Institutional controls would ensure that the affected groundwater would not be used in the future, thereby maintaining the current lack of exposure to, and risks from, groundwater contaminants. Groundwater monitoring would ensure that groundwater contamination is not migrating off site to the downgradient production well in the Santa Margarita River basin (10S/04W-07R02, located approximately 1,850 feet southwest of the site). Groundwater monitoring would also ensure that groundwater contamination does not adversely impact any production wells and/or nearby surface water bodies. The source area soil removal should enhance the effectiveness of this remedy.

Institutional controls would be implemented to ensure that the affected groundwater would not be extracted or used for any purpose in the future until appropriate regulatory standards have been met. These institutional controls would ensure that the RAOs are achieved while COCs are still present in the subsurface. Institutional controls include restrictions on future access to the groundwater in the immediate vicinity and downgradient of the site. Land use restrictions would include enforcing long-term restrictions the installation of water supply wells at Site 1111. Additionally, any proposal to increase groundwater extraction rates from existing Base production wells in the vicinity of Site 1111 would have to be carefully and thoroughly reviewed, and enhanced

ground water monitoring activities may be required to ensure site conditions are protective of human health and the environment. The intent of these restrictions would be to eliminate the pathway for potential receptor exposures to site-related contaminants until plume concentrations are reduced below action levels. Land-use controls to restrict access to contaminated groundwater would be implemented, and enforced by periodic on-site inspections and audits. An institutional control plan would also be prepared and implemented to document the adherence to controls. The institutional control plan would be subject to periodic (5-year) reviews to assess the effectiveness at meeting RAOs.

If institutional controls, or land use controls, are chosen as the selected remedy for this site, a detailed description of the institutional controls or land use controls will need to be included in the ROD and Remedial Action Plan (RAP). The DON memo titled *Monitoring and Enforcement of Land Use Controls* (U.S. Navy, 2003) provides specific items to be included in the ROD and RAP, including listing the parties responsible for enforcing the land use controls, and the need for five-year reviews.

If institutional controls are selected to be all or part of the remedy for the OU 5 sites, such controls will be implemented by MCB Camp Pendleton as part of the site approval process. Site approval is required for all projects at the Base involving construction, acquisition, or modification. Once site approval is requested, MCB Camp Pendleton Environmental Security must be consulted for environmental approvals, including for NEPA determination if applicable. The form that is used to initiate the site approval process is called the "Preliminary Environmental Data Sheet." Currently Mark Bonsavage is the primary point of contact for projects potentially affecting IR sites. If Mark vacated the position, whoever assumed the roll of IRP Manager would review the site approvals.

The role of Environmental Security in the site approval process includes maintaining a GIS system for environmental constraints at the Base, including wetlands, sensitive species, and IR sites. If a planned activity requires environmental review or falls within an area specified on the Environmental Operations map, Environmental Security must review the proposed actions and make recommendations.

This alternative also involves implementing a long-term monitoring program to document that groundwater contamination is stable, and to detect any off-site contaminant migration. The initial monitoring network for this alternative is presented in Table 3-3. This table summarizes the target zones for monitoring the VOC plume, the monitoring locations and objectives for each zone, and the monitoring parameters and frequency for each location. The groundwater monitoring well network for Site 1111 should provide adequate plume resolution in three dimensions to adequately protect the Base production well. Parameters to be monitored include VOCs and hydrogeologic parameters.

Initially, all existing wells at Site 1111 would be sampled for VOCs to actualize site conditions and contaminant distributions throughout the plume. The results of the baseline sampling would be used to select a list of strategic wells for tracking future plume movement. Two new wells would be required, one to assess current conditions within the source area, and one to provide for a sentry well at a designated downgradient point between the plume boundary and production well 10S/04W-07R02 in the Santa Margarita Groundwater Basin. The groundwater monitoring well network should provide adequate plume resolution in three dimensions and include vertical profiling of soil and groundwater concentrations during monitoring well installation to ensure the optimum placement of well screens for plume and remedy performance

monitoring. If the RG were exceeded at this sentry well at some time in the future, then additional analysis and/or remedial measures would be implemented to protect the downgradient production well.

Because of the dynamic nature of contaminant distribution in the plume, the monitoring network and sampling frequency would be continually reevaluated and revised at least once a year to modify the selection of monitoring locations in response to plume changes. The 5-year reviews would include an assessment of the long-term monitoring data to confirm changes in the extent and magnitude of contamination over time, confirm the effectiveness of institutional controls at eliminating exposure vectors, and reassess the potential for additional remedial actions to accelerate restoration of the site.

Based on the NAS calculations, it would take approximately 3.4 years to reach MCLs and 4.9 years for background provided the source of contamination has been removed as included in Alternative 1111-S3. For cost estimating purposes, it is assumed that monitoring would be conducted semiannually for the first 2 years and annually for years 3 through 5.

#### 3.12.2.3 Alternative 1111-G3: Monitored Natural Attenuation with Alternative 1111-G2

This alternative involves soil source removal (Alternative 1111-S3), the institutional controls, and limited groundwater monitoring to ensure that there is no downgradient migration of contaminated groundwater (Alternative 1111-G2), and a long-term monitoring program to document the performance and effectiveness of natural attenuation to contain and degrade groundwater contaminants. The logistics associated with the implementation of this alternative would be addressed in a Remedial Action/MNA Work Plan for the site. The success of this alternative relies on the ability of natural subsurface physical and biological attenuation processes (e.g., dispersion, degradation, sorption, and volatilization) to control plume expansion and reduce VOC concentrations to acceptable levels within a reasonable timeframe. The source area soil removal should further enhance the effectiveness MNA remedy.

The overall objectives of the performance monitoring for MNA at Site 1111 include:

- Demonstrate that natural attenuation is occurring according to expectations.
- Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other) that may reduce the efficacy of natural attenuation processes.
- Identify any potentially toxic and/or mobile transformation by-products.
- Verify that the plume is not expanding.
- Verify there is no unacceptable impact to downgradient receptors.
- Demonstrate the efficacy of institutional controls to protect potential receptors.
- Verify attainment of remediation objectives.

MNA would include collection of site-specific monitoring data to demonstrate continued reduction in the total mass of contaminants in groundwater over time. The primary classes of parameters to be monitored include VOCs, geochemical indicators of transformation processes, and hydrogeologic parameters. MNA quantitative models such as NAS (USGS, 2003) or BIOCHLOR (USEPA, 2002a) will be used to help understand site processes, locate monitoring points, estimate attenuation rates, and evaluate the effects changing conditions on MNA effectiveness. This alternative

assumes that no engineered groundwater remediation activities would be conducted. Rather, this alternative relies on natural attenuation mechanisms to control plume expansion and remove CAHs from groundwater. Long-term monitoring would be required to document CAH removal from the groundwater system, and to verify that MNA is proceeding to acceptable endpoints to achieve cleanup RGs over a timeframe that is comparable to engineered remedial technologies. The plan would comply with USEPA guidance for performance monitoring of MNA remedies for VOCs in groundwater (USEPA, 2004a).

Table 3-4 presents the proposed initial MNA monitoring network for groundwater at Site 1111. This table summarizes the target zones for monitoring the VOC plumes, monitoring locations and objectives, and monitoring parameters and frequency of sampling. The groundwater monitoring well network for Site 1111 should provide adequate plume resolution in three dimensions to adequately protect the Base production well. Initially, all existing wells at Site 1111 would be sampled for VOCs and geochemical parameters to actualize site conditions and establish baseline concentrations for contaminant distribution throughout the plume. The results of the baseline sampling would be used to determine the need for any modifications to the initial MNA monitoring network.

An initial network of 11 groundwater monitoring wells (seven existing and four new) would be sampled to monitor for VOCs and geochemical parameters that act as indicators of biodegradation. The long-term monitoring network would consist of performance well and compliance (i.e., sentry) well monitoring (AFCEE, 2000; Weidemeier and Haas, 2002). Four new wells would be required: two new wells are the same as discussed for Alternative 1111-G2, a third new well to assess plume centerline, and a fourth new well to establish background conditions. The new data would provide the basis to refine the conceptual site model and to modify monitoring network locations, parameters, and frequencies in response to changes in site conditions.

Site MNA data would be used to evaluate plume behavior and judge the effectiveness of the MNA remedy, the adequacy of the monitoring program, and the adequacy of the conceptual site model for MNA. Based on these judgments, decisions would be made for subsequent phases of the site remediation, including:

- Continue MNA without change
- Modify the performance monitoring program
- Modify the institutional controls
- Implement a contingency or alternative remedy
- Terminate MNA

The long-term monitoring plan would include site-specific criteria to define the conditions that indicate the appropriateness of these decisions (e.g., increased or decreased monitoring parameters or frequency, new sampling points, contingency remedy, etc.), including action-triggering RGs enforceable at sentry wells. Periodic site reviews (i.e., 5-year reviews) also could be conducted using the long-term monitoring data to confirm changes in the extent and magnitude of contamination over time, assess dissolved contaminant plume dynamics, document the continued destruction of contaminant mass, confirm the effectiveness of institutional controls at eliminating exposure vectors, and reassess the potential for additional remedial actions to accelerate restoration of the site.

There is limited evidence that anaerobic biodegradation is occurring at Site 1111. Groundwater geochemistry indicates reducing conditions (low ORP, elevated iron, and some methane and nitrate evidence) despite some higher DO levels in some samples. Despite this, the most recent (2003) monitoring did not encounter any intermediate degradation products. The site may be electron donor limited, in which case aerobic conditions could re-establish over time. PCE concentrations appear to have decreased over time in 1111MW-01 based on the available data. However, since the concentrations at this site appear to be lower than the MCL with exception of the groundwater underlying the source area, any remaining PCE will likely be attenuated by simple dilution and dispersion. TCE concentrations in excess of the MCLs were previously (1998) present within the source area; however, this well (1111MW-03) was not usable for more recent monitoring events (2002, and 2003), and so current TCE concentrations within the source area are not known.

For cost estimating purposes, it is assumed that monitoring would be conducted semiannually for the first 2 years and annually for years 3 through 5. Based on the NAS calculations, it would take approximately 3.4 years to reach MCLs and 4.9 years for background provided the source of contamination has been removed as included in Alternative 1111-S3.

Performance and compliance monitoring for MNA would continue until the RAOs have been met, followed by a period of verification monitoring. The sampling frequencies, monitoring locations, and parameters used during verification monitoring may differ from those used during performance monitoring, and would be determined based on site conditions. Once verification monitoring shows that the MNA remedy goals have been met, MNA would be terminated.

#### 3.12.2.4 Alternative 1111-G4: Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3

Alternative 1111-G4 is a minor variation of Alternative 1111-G3 that combines all of the elements of the latter with enhanced in situ bioremediation to further reduce the concentrations of CAH compounds in groundwater in the source area and expedite cleanup. The in situ bioremediation treatment will enhance the MNA remedy by promoting the reducing conditions needed to stimulate anaerobic reductive dechlorination.

Microorganism populations are probably currently insufficient to complete the reductive dechlorination process under ambient conditions (as evidenced by virtually no PCE degraded at Site 1111). The purposes of adding the carbon substrate are to (1) stimulate biological growth to the extent that primary electron acceptors (oxygen, nitrate, iron, manganese) are depleted and strongly reducing conditions favorable for reductive dechlorination are established, and (2) provide the microorganisms with a sufficient food source so that the population will increase.

Off-site removal and disposal of contaminated soil will be performed as described under Alternative 1111-G3 (Section 3.6.2.3). A layer of bark mulch, or other solid organic substrate, will be backfilled into the portion of the excavation that will be in contact with the groundwater, and the remaining portion of the excavation will be backfilled with clean soil. This alternative is designed to provide indigenous microorganisms with an additional source of organic carbon and hydrogen in the form of organic substrate to promote more anaerobic conditions in the aquifer. Conceptually, the choice of the organic substrate (e.g., bark mulch, compost) is an important design consideration, but

will not affect the evaluation of this remedial alternative if the organic substrate will be selected and delivered to the subsurface using the current state-of-practice (e.g., AFCEE et al., 2004). Based on the flexibility of this procedure and the relatively low concentrations of groundwater contaminants, a field treatability study would not be required prior to implementation.

The organic carbon delivered to the subsurface is designed to further reduce COCs in groundwater to below the MCL by enhancing natural attenuation processes. It is assumed that groundwater monitoring, which would include the same monitoring wells as described for Alternative 1111-G3, would also be required for 2.6 years for MCLs and 4.1 years for background following excavation and treatment.

### 3.12.3 Detailed Analysis of Alternatives

The objective of the detailed analysis of alternatives is to present and interpret the relevant information necessary to select the most appropriate remedy for Site 1111 groundwater. The detailed analysis consists of an assessment of the individual alternatives described in the previous section against the nine NCP criteria. The results of this analysis provide the basis for the selection of an appropriate remedy for the site, and demonstrate satisfaction of the CERCLA remedy selection requirements in the ROD.

The following sections present the detailed analysis of the four remedial alternatives developed for the Site 1111 groundwater.

#### 3.12.3.1 Overall Protection of Human Health and the Environment

An analysis of how well each alternative meets overall protection of human health and the environment is provided below.

Alternative 1111-G1: No Action

The no action alternative includes no treatment and no control of exposure pathways. Under this alternative, short and long-term risks would be unacceptable if contaminated groundwater were used for domestic purposes. Therefore, this alternative does not provide adequate protection of human health if the groundwater in the plume area were to be used as drinking water in the future. At present, no risk exists to human receptors from the contaminated groundwater because the impacted groundwater is not used for domestic purposes.

Long-term risk may be reduced as the contaminant concentrations naturally attenuate over time. Although it is extremely unlikely that a water production well would ever be constructed and screened in the shallow groundwater at Site 1111, the RME risk to a hypothetical adult domestic water user, based on default exposure assumptions and USEPA toxicity factors, was estimated to be $2 \times 10^{-3}$. The maximum route-specific adult hazard index was estimated to be 18 and the maximum child hazard index was 43. These estimates, which are based on maximum detected groundwater concentrations, exceed the upper end of the USEPA risk range and target hazard index of one. Groundwater fate-and-transport analysis indicates that VOC contaminants in groundwater would remain at a steady state indefinitely provided current conditions do not change.

Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3

The institutional controls alternative adequately protects human health and the environment by restricting future use of the impacted groundwater and effectively eliminating the exposure pathway. Groundwater monitoring will allow a periodic assessment of the groundwater quality, facilitate plume tracking, and permit a periodic evaluation of additional actions, if necessary. Implementation of this alternative would not have any adverse environmental or health impacts.

Alternative 1111-G3: Monitored Natural Attenuation with Alternative 1111-G2

MNA will allow a periodic assessment of the groundwater quality, facilitate plume tracking, and permit a periodic evaluation of additional actions, if necessary. Implementation of this alternative would not have any adverse environmental or health impacts. Long-term risk would be reduced as the contaminant concentrations naturally attenuate over time.

Alternative 1111-G4: Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3

Alternative 1111-G4 would protect human health and the environment by reducing the contaminant mass. Implementation of Alternative 1111-G4 would shorten the time frame needed to reach MCLs. The estimated timeframe for enhanced bioremediation to achieve cleanup goals for site groundwater is 2.6 to 4.1 years based on the discussion in Section 3.12.2.4. Additional protection of human health and the environment would result from more rapid attainment of MCLs or background levels.

3.12.3.2 Compliance with ARARs

An analysis of how well each alternative complies with ARARs is provided below.

Alternative 1111-G1: No Action

The no action alternative would not comply with ARARs. Contaminant concentrations detected in the groundwater exceed both MCLs and background levels, which are chemical-specific ARARs for Site 1111 groundwater. No location-specific ARARs are identified for the no action alternative. Although MCLs or background (nondetectable) levels would eventually be attained in groundwater through natural attenuation processes, Alternative 1111-G1 would not meet RCRA requirements for closure with no post-closure care or RCRA groundwater monitoring requirements (Appendix A).

Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3

Alternative 1111-G2 would comply with ARARs. MCLs or background (nondetectable) levels would be attained in groundwater through natural attenuation processes. Alternative 1111-G2 would also comply with RCRA hazardous waste and groundwater protection requirements. This alternative includes monitoring to verify that contamination is not migrating offsite and complies with federal and state groundwater monitoring requirements (Appendix A). Upon reaching cleanup goals, Alternative 1111-G2 would comply with RCRA closure with no post-closure care requirements for groundwater (Appendix A).

Alternative 1111-G3: Monitored Natural Attenuation with Alternative 1111-G2

Alternative 1111-G3 would comply with ARARs. MCLs or background (nondetectable) levels would be attained in Site 1111 groundwater through natural attenuation processes. Alternative 1111-G3 would also comply with RCRA hazardous waste and groundwater protection requirements. This alternative includes monitoring to evaluate the effectiveness of natural attenuation and complies with federal and state groundwater monitoring requirements (Appendix A). Upon reaching cleanup goals, Alternative 1111-G3 would comply with RCRA closure with no post-closure care requirements for groundwater (Appendix A).

Alternative 1111-G4: Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3

Alternative 1111-G4 would comply with ARARs. MCLs or background (nondetectable) levels, which are considered chemical-specific ARARs for this site, would be attained through contaminant mass reduction via enhanced biodegradation. Alternative 1111-G4 would also comply with RCRA hazardous waste and groundwater protection requirements. Alternative 1111-G4 includes monitoring to evaluate treatment effectiveness and complies with federal and state groundwater monitoring requirements (Appendix A). Upon reaching cleanup goals, Alternative 1111-G4 would comply with RCRA closure with no post-closure care requirements for groundwater (Appendix A).

3.12.3.3 Long-Term Effectiveness and Permanence

An analysis of the long-term effectiveness and permanence for each alternative is provided below.

Alternative 1111-G1: No Action

This alternative would not provide any actions or controls to reduce the existing contaminant levels or risks to human health and the environment. Although fate-and-transport analysis indicates contaminant levels would eventually reach MCLs and background through natural attenuation process, no measures are provided to monitor its effectiveness or to control exposure during the duration of this alternative. In addition, implementation of this remedial alternative may have adverse consequences should the groundwater resources in the vicinity and downgradient of Site 1111 be needed to meet current and future water requirements. Therefore, the long-term effectiveness and permanence criterion is rated low for this alternative.

Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3

Alternative 1111-G2 does provide actions to reduce risks to human health and the environment and to monitor groundwater to verify there is no migration offsite. It provides restrictions of future groundwater use, which limits the potential for human exposure and risks. Therefore, this alternative would provide moderate long-term effectiveness and permanence.

Alternative 1111-G3: Monitored Natural Attenuation with Alternative 1111-G2

Alternative 1111-G3 does provide actions to reduce risks to human health and the environment and to monitor continued reduction in contamination levels. Long-term monitoring proposed for this alternative further reduces the potential for exposure by periodically assessing the extent of contamination and the degree of plume reduction. The current contamination levels exceed cleanup goals. However, based on fate-and-

transport analyses, this alternative would reduce contaminant levels to MCLs and background (nondetectable) levels via natural attenuation while effectively controlling and monitoring potential exposure throughout the duration. Therefore, this alternative would provide moderate long-term effectiveness and permanence.

Alternative 1111-G4: Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3

Alternative 1111-G4 would provide moderate to high long-term effectiveness and permanence. The enhanced attenuation would reduce the contaminant mass from the groundwater plume and would accelerate the time frame for attaining the remedial objectives. Long-term monitoring proposed for this alternative further reduces the potential for exposure by periodically assessing the extent of contamination and the degree of migration.

3.12.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

An analysis of the reduction of toxicity, mobility, or volume through treatment for each alternative is presented below.

Alternative 1111-G1: No Action

This alternative would not include active treatment and would not provide for any reduction of toxicity, mobility, or volume through treatment of the contaminated groundwater. Therefore, this criterion is rated low for this alternative. However, passive remediation via natural attenuation is expected to reduce groundwater contaminant levels to MCLs and background (nondetectable) levels.

Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3

This criterion is rated moderate for Alternative 1111-G2 because it does not include active treatment of the contaminated groundwater. However, remediation via natural attenuation is expected to reduce groundwater contaminant levels to MCLs and background (nondetectable) levels.

Alternative 1111-G3: Monitored Natural Attenuation with Alternative 1111-G2

This criterion is rated moderate for Alternative 1111-G3 because it does not include active treatment of the contaminated groundwater. However, remediation via natural attenuation is expected to reduce groundwater contaminant levels to MCLs and background (nondetectable) levels.

Alternative 1111-G4: Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3

The enhanced bioremediation proposed for Alternative 1111-G4 would reduce the contaminant mass and the volume of contaminated groundwater requiring remediation as treatment proceeds. Similarly, the aggregate toxicity of the contaminants in groundwater would be reduced as their concentrations are reduced over time. Therefore, the reduction of toxicity, mobility, and/or volume for Alternative 1111-G4 is rated as moderate to high.

3.12.3.5 Short-Term Effectiveness

An analysis of the short-term effectiveness for each alternative is provided below.

Alternative 1111-G1: No Action

No remedial actions would be implemented under the no action alternative; therefore, this evaluation criterion is rated low.

Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3

Field activity associated with this alternative is limited to installing and sampling groundwater monitoring wells. A site-specific sampling plan, as well as a site-specific health and safety plan, would be prepared and implemented. Field personnel participating in the sampling activity would wear PPE as specified in the health and safety plan. Short-term effectiveness is rated moderate for this alternative.

Alternative 1111-G3: Monitored Natural Attenuation with Alternative 1111-G2

Field activity associated with this alternative is limited to installing and sampling groundwater monitoring wells. A site-specific sampling plan, as well as a site-specific health and safety plan, would be prepared and implemented. Field personnel participating in the sampling activity would wear PPE as specified in the health and safety plan. Short-term effectiveness is rated moderate for this alternative.

Alternative 1111-G4: Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3

Field activities associated with this alternative include placing the bark mulch or other solid organic substrate during backfilling of the excavation discussed in Alternative 1111-S3 plus installing and sampling groundwater monitoring wells. A site-specific sampling plan and a site-specific health and safety plan would be prepared and implemented. Potential exposure and protection procedures for workers would be addressed in the health and safety plan. Potential short-term risks to site workers would be associated with dust emissions and direct contact with contaminated groundwater during well installation. Field personnel participating in the construction and sampling activities would wear PPE as specified in the health and safety plan. Implementation of Alternative 1111-G4 is not expected to result in any adverse environmental impacts. Areas disturbed by implementing this alternative would be restored upon completion of the excavation discussed in Alternative 1111-S3 and monitoring well construction. Short-term effectiveness is rated moderate to high for Alternative 1111-G4.

3.12.3.6 Implementability

An analysis of the implementability of each alternative is provided below.

Alternative 1111-G1: No Action

This alternative is not rated because no action would be taken.

Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3

Implementability is ranked high for Alternative 1111-G2. Limiting groundwater use is an administrative process that is readily implementable. The Base would have primary responsibility for implementing this alternative and has the authority and capability to establish appropriate safeguards and to monitor and enforce compliance. Existing staff within the Base Environmental Security Office would coordinate all on-Base construction activities to ensure appropriate environmental review. Base Environmental Security Office staff would work closely with Base water resources staff to ensure proposed

modifications to groundwater extraction rates from production wells in the vicinity of and downgradient of the site do not exacerbate site conditions and/or have adverse consequences. Institutional controls for IR sites are maintained on a central GIS that is readily accessible. Downgradient monitoring wells already exist at Site 1111. New wells can be installed quickly; equipment and services are readily available. This option involves selection of monitoring locations based on the predicted migration rate of the plume.

Alternative 1111-G3: Monitored Natural Attenuation with Alternative 1111-G2

Implementability is ranked high for Alternative 1111-G3. A monitoring network already exists at the site. New wells can be installed quickly; equipment and services are readily available. This option involves selection of monitoring locations based on the predicted attenuation rate of the plume.

Alternative 1111-G4: Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3

Implementability is ranked high for Alternative 1111-G4. A monitoring network already exists at the site. New wells can be installed quickly; equipment and services are readily available. Bark mulch, or other solid organic substrate, are readily available and easy to place during backfilling of the excavation discussed in Alternative 1111-S3. Enhanced bioremediation is a commonly used technology and readily implementable.

3.12.3.7 Cost

A summary of the costs is provided below.

Alternative 1111-G1: No Action

No costs are associated with Alternative 1111-G1.

Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3

Resulting from the NAS calculations, it is assumed that monitoring will be conducted for 3.4 years for MCLs and 4.9 years for background. The total cost for Alternative 1111-G2 is approximately $185,000 to achieve MCLs and approximately $196,100 to reach background conditions. The capital costs include the preparation of a work plan, sampling and analysis plan, quality assurance project plan (QAPP), health and safety plan, long-term monitoring plan, and the installation of two additional monitoring wells to supplement the existing well network. The O&M cost includes labor, maintenance, material, shipping, analysis, waste disposal, data validation, and report preparation. A detailed breakdown of these costs is presented in Appendix F3.

Alternative 1111-G3: Monitored Natural Attenuation with Alternative 1111-G2

Resulting from the NAS calculations, it is assumed that monitoring will be conducted for 3.4 years for MCLs and 4.9 years for background. The total cost for Alternative 1111-G3 is approximately $267,700 to achieve MCLs and approximately $306,200 to reach background conditions. This includes approximately $160,600 in capital costs. The capital costs include the preparation of a work plan, sampling and analysis plan, QAPP, health and safety plan, and long-term monitoring plan, as well as the installation of four additional monitoring wells to supplement the existing well network. The O&M cost includes labor, maintenance, material, shipping, analysis, waste disposal, data validation, and report preparation. A detailed breakdown of these costs is presented in Appendix F3.

Alternative 1111-G4: Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3

Based from the NAS calculations, it is assumed that monitoring will be conducted for 2.6 years to reach MCLs and 4.1 years to reach background conditions. The total cost for Alternative 1111-G3 is approximately $306,600 to achieve MCLs and approximately $345,100 to reach background conditions. This includes approximately $199,500 in capital costs. The capital costs include all of the Alternative 1111-G3 capital costs plus the cost to emplace the bark mulch, or other solid organic substrate. The O&M cost includes all of the Alternative 1111-G3 O&M costs. A detailed breakdown of these costs is presented in Appendix F3.

## 3.13 Comparative Analysis

This section provides a comparative evaluation of the alternatives for the Site 1111 using the nine NCP criteria used in Section 3.12 and discusses the relative advantages and disadvantages of the alternatives. Table 3-5 presents a brief description of each alternative, and the comparative analysis is summarized below.

### 3.13.1 Overall Protection of Human Health and the Environment

Alternatives 1111-G1, 1111-G2, and 1111-G3 would reduce risk to acceptable levels via natural attenuation. Alternative 1111-G1 is not considered to be protective of human health and the environment because it would not implement any measures to limit potential exposure or monitor the effectiveness of the remedial action. Alternative 1111-G2 is considered to be protective by continued enforcement of use restrictions and groundwater monitoring to verify there is no contaminant migration downgradient. Alternative 1111-G3 is considered to be protective by continued enforcement of use restrictions and groundwater monitoring. Both Alternatives 1111-G2 and 1111-G3 are estimated to achieve MCLs and background (nondetectable) levels in 3.4 and 4.9 years, respectively. Alternative 1111-G4 is also considered to be protective by continued enforcement of use restrictions and groundwater monitoring and is estimated to achieve MCLs and background (nondetectable) levels in 2.6 and 4.1 years, respectively. Alternative 1111-G4 provides active treatment via enhanced attenuation using carbon addition to reduce contaminant concentrations. However, no additional protection to human health and the environment is provided in Alternative 1111-G4.

### 3.13.2 Compliance with ARARs

Alternative 1111-G1 would not comply with RCRA closure and postclosure or RCRA groundwater monitoring requirements. Alternatives 1111-G2, 1111-G3, and 1111-G4 would comply with all ARARs, including chemical-specific, location-specific, and action-specific ARARs. Chemical-specific ARARs would be achieved for Alternative 1111-G3 via natural attenuation, and for Alternative 1111-G4 through enhanced attenuation using carbon addition.

### 3.13.3 Long-Term Effectiveness and Permanence

Alternative 1111-G1 would not provide any remedial actions or controls; therefore, long-term effectiveness and permanence are considered to be low for this alternative. The long-term effectiveness of Alternative 1111-G2 would be dependent on continued enforcement of use restrictions and monitoring to ensure there is no contaminant migration off site. The long-term effectiveness of Alternative 1111-G3 would be

dependent on the effectiveness of natural attenuation processes acting on the groundwater contamination. Fate-and-transport analysis indicates that natural attenuation would eventually reduce the VOC contamination to MCLs and background (nondetectable) levels in about 3.4 to 4.9 years following removal of source soils. Alternative 1111-G4 provides a higher degree of long-term effectiveness and permanence through the active treatment of VOCs in groundwater via enhanced attenuation using carbon addition and VOC contamination should reach MCLs and background (nondetectable) levels in about 2.6 to 4.1 years, respectively.

### 3.13.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternatives 1111-G1, 1111-G2, and 1111-G3 would not reduce toxicity, mobility, or volume through active treatment. However, these alternatives achieve contaminant reduction via natural attenuation. Alternative 1111-G4 provides a higher degree of reduction in toxicity, mobility, and volume through enhanced attenuation using carbon addition.

### 3.13.5 Short-Term Effectiveness

Alternative 1111-G1 is not effective in the short term because no response actions would be taken. Alternatives 1111-G2, 1111-G3, and 1111-G4 pose minimal risk to site workers during groundwater sampling and analysis.

### 3.13.6 Implementability

This criterion is not applicable to Alternative 1111-G1 because no actions or controls would be implemented as part of this alternative. Alternatives 1111-G2 and 1111-G3 are readily implementable and rank the highest in implementability. The construction activities associated with Alternative 1111-G4 are common techniques and are also readily implementable.

### 3.13.7 Cost

No cost is associated with Alternative 1111-G1. Alternative 1111-G2 is the least expensive, with estimated costs of $185,000 to achieve MCLs and $196,100 to reach background conditions. Alternative 1111-G3 is between Alternative 1111-G2 and Alternative 1111-G3, with a cost of approximately $267,700 to achieve MCLs and approximately $306,200 to reach background conditions. Alternative 1111-G4 is the most expensive, with a cost of approximately $306,600 to achieve MCLs and approximately $345,100 to reach background conditions. A summary of the costs associated with the implementation of each of the three remedial alternatives proposed for the Site 1111 Groundwater is presented in Appendix F3.

### 3.13.8 Summary of Comparative Analysis

The results of the comparative analyses are summarized below.

| Criteria | Alternative | | | |
|---|---|---|---|---|
| | 1111-G1[a] | 1111-G2[b] | 1111-G3[c] | 1111-G4[d] |
| **Threshold Criteria** | | | | |
| Overall Protection of Human Health and the Environment | No | Yes | Yes | Yes |
| Compliance with ARARs | No | Yes | Yes | Yes |
| **Balancing Criteria** | | | | |
| Long-Term Effectiveness and Permanence | Low | Moderate | Moderate | Moderate to High |
| Reduction of Toxicity, Mobility, or Volume by Treatment | Low | Moderate | Moderate | Moderate to High |
| Short-Term Effectiveness | Low | Moderate | Moderate | Moderate to High |
| Implementability | Not Rated | High | High | High |
| Cost ($ million) | 0 | MCLs: $0.19 Background: $0.20 | MCLs: $0.27 Background: $0.31 | MCLs: $0.31 Background: $0.35 |
| **Remedial Timeframe** | | | | |
| Time to Achieve MCLs (years) | 50 | 3.4 | 3.4 | 2.6 |
| Time to Achieve background levels (years) | 50 | 4.9 | 4.9 | 4.1 |

[a] No Action.
[b] Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3.
[c] Monitored Natural Attenuation with Alternative 1111-G2.
[d] Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3

Alternative 1111-G1 is not protective of human health; does not meet ARARs; provides little short- or long-term effectiveness and permanence; achieves no reduction in toxicity, mobility, or volume through active treatment; and has no associated cost.

Alternatives 1111-G2, 1111-G3, and 1111-G4 would provide adequate protection of human health and the environment and comply with ARARs. Alternative 1111-G2 provides short-term effectiveness and ease of implementation, but it does not provide active treatment of the groundwater contamination. This alternative would provide the monitoring necessary to track plume movement, as well as the necessary restrictions to limit exposure to the site contaminants. Alternative 1111-G2 is the least expensive alternative.

Alternative 1111-G3 would provide a higher degree of long-term effectiveness and permanence by reaching MCLs sooner and a somewhat decreased remediation time because the source would have been removed. Alternative 1111-G4 would provide a higher degree of long-term effectiveness and permanence by reaching MCLs sooner; the highest reduction in toxicity, mobility, or volume through treatment; and a somewhat decreased remediation time. For both alternatives 1111-G2 and 1111-G3, groundwater contaminants are estimated to reach RGs in about 3.4 to 4.9 years and for 1111-G4, groundwater contaminants are estimated to reach RGs in about 2.6 to 4.1 years. Alternative 1111-G4 would provide a cost-effective treatment alternative to the passive options provided by Alternatives 1111-G2 and 1111-G3.

# Table 3-1
## Site 1111 Proposed Remediation Goals
## MCB Camp Pendleton, California

| Contaminant of Concern | Maximum Concentration | Background Concentration [a] 0 to 5 feet | HHRA Preliminary Remediation Goal [b] | | ERA Preliminary Remediation Goals [c] | Soil Removal RG to Meet GWQGs [d] | Proposed Remediation Goal |
|---|---|---|---|---|---|---|---|
| | | | California Modified Toxicity Data | USEPA Toxicity Data | | | |
| **Dioxins/Furans (ng/kg)** | | | | | | | |
| 2,3,7,8-TCDD TEQ | 9,200 [e] | 4.1 | 20 | 17 | 44 | -- | 17 |
| **Volatile Organic Compounds (µg/kg)** | | | | | | | |
| 1,2,4-Trimethylbenzene | 220,000 | -- | -- | -- | -- | 575 | 575 |
| 1,3,5-Trimethylbenzene | 70,800 | -- | -- | -- | -- | 420 | 420 |
| Chloroform [g] | 400 | -- | -- | -- | -- | 650 | 650 |
| *cis*-1,2-DCE | 840 | -- | -- | -- | -- | 50 | 50 |
| Methylene Chloride | 1,200 | -- | -- | -- | -- | 33 | 33 |
| Naphthalene | 40,600 | -- | -- | -- | -- | 400 | 400 |
| PCE | 980 | -- | -- | -- | -- | 200 | 200 |
| TCE | 11,500 | -- | -- | -- | -- | 72 | 72 |
| **Semivolatile Organic Compounds (µg/kg)** | | | | | | | |
| Benzo(a)Anthracene | 260 | -- | -- | -- | -- | 200 | 200 |
| **Pesticides (µg/kg)** | | | | | | | |
| DDD/DDE/DDT | 89,700 | -- | -- | -- | -- | 2,450 | 2,450 |
| Hexachlorobenzene | 1,800 | -- | -- | -- | 650 | 115 | 115 |
| Heptachlor Epoxide | 9 | -- | -- | -- | -- | 135 | 135 |
| **Inorganics (mg/kg)** | | | | | | | |
| Antimony | 3,200 | 8.8 | -- | -- | 12 | | 12 |
| Arsenic | 72 | 4.6 | 1.8 | 1.8 | -- | -- | 4.6 [i] |
| Mercury | 3,700 | 0.08 | -- | -- | 8.5 | -- | 8.5 |

a = Santa Margarita Basin Background (SWDIV, 1997)
b = The HHRA Preliminary RG with the lowest concentration was selected from among the combined receptor Preliminary RGs (as derived in Appendix D) as the final RG for each COC.
c = The value selected, as a site- and chemical-specific Ecological Preliminary RG, is the lowest of the Ecological Preliminary RGs for any wildlife receptor, derived using an effect-based TRV (Appendix E)
d = groundwater quality goal for soil
e = Calculated toxicity equivalent for humans
i = Proposed remediation goal was set at background
g = Total Trihalomethanes as Chloroform

µg/kg = micrograms per kilogram
mg/kg = milligrams per kilogram
ng/kg = nanograms per kilogram
NA - not applicable
-- Indicates chemical is not a chemical of concern for that category

Table 3-2

Site 1111 Summary of Detailed Analysis of Soil Alternatives
OU 5 FS, MCB Camp Pendleton, California

| NCP Criterion | Alternative 1111-S1 | Alternative 1111-S2 | Alternative 1111-S3 |
|---|---|---|---|
| | No Action | Institutional Controls | Soil Excavation, Backfill, and Off-Base Land Disposal |
| **Overall Protection of Human Health and the Environment** | | | |
| Human Health Protection | Provides no reduction in baseline risks. Existing soil contamination will remain. Not protective of human health. | Existing soil contamination will remain. Eliminates potential exposure by controlling site use. Protective of human health. | Reduces risks by excavating and removing all contaminated soil exceeding RGs, and disposing of it in an off-base licensed disposal facility. Site would be backfilled with clean imported soil. Protective of human health. |
| Environmental Protection | Soil contamination poses a risk to local habitats and potential ecological receptors. Existing soil contamination could pose a threat to groundwater. Not protective of the environment. | Soil contamination poses a risk to local habitats and potential ecological receptors. Existing soil contamination could pose a threat to groundwater. Not protective of the environment. | Reduces risks by excavating and removing all contaminated soil exceeding ecological risk and groundwater impact levels. Site would be backfilled with clean imported soil. Protective of the environment. |
| **Compliance with ARARs** | | | |
| Chemical-Specific ARARs | Does not comply with human health risk-based and ecological ARARs. | Complies with risk-based ARARs. | Complies with risk-based ARARs. |
| Location-Specific ARARs | Would not comply with location-specific requirements of the Endangered Species Act and RCRA requirements for sites located within a floodplain. | Would not comply with location-specific requirements of the Endangered Species Act and RCRA requirements for sites located within a floodplain. | On-site excavation would comply with action- and location-specific requirements of the Endangered Species Act and the Migratory Birds Act. Coordination with the USFWS would be required.. |
| Action-Specific ARARs | No action-specific ARARs are identified for the no action alternative because no action is taken. | Partially meets this requirement by providing use restrictions and site monitoring/maintenance for surface soil erosion. | On-site excavation and transportation would meet RCRA ARARs and APCD emission ARARs. Complies with RCRA clean closure with no post-closure requirements. |

Table 3-2

Site 1111 Summary of Detailed Analysis of Soil Alternatives
OU 5 FS, MCB Camp Pendleton, California

| NCP Criterion | Alternative 1111-S1 | Alternative 1111-S2 | Alternative 1111-S3 |
|---|---|---|---|
| | No Action | Institutional Controls | Soil Excavation, Backfill, and Off-Base Land Disposal |
| **Long-Term Effectiveness and Permanence** | | | |
| Effectiveness to reduce risk | Existing risk will remain because the contamination will not be removed. Would not provide long-term effectiveness and permanence. | Would reduce risk by eliminating potential exposure to soil contaminants. Provides long-term effectiveness for human health protection as long as institutional controls are enforced. Provides minimal long-term effectiveness for ecological risk protection due to flooding potential. | Would reduce risk by excavating and removing all contaminated soil above action levels. Provides long-term effectiveness and permanence. |
| Adequacy and Reliability of Controls | Provides no reliable or adequate controls for remaining contamination. | Institutional controls would adequately and reliably reduce human health exposure pathways and risks. Not protective of ecological receptors or groundwater. | Excavation and off-base disposal will adequately, reliably, and permanently reduce human health, ecological, and groundwater exposure pathways and risks. |
| Need for 5-Year Review | No review will be done. | A 5-year review will be conducted. | No review will be conducted. |
| **Reduction of Toxicity, Mobility, or Volume Through Treatment** | | | |
| Treatment Process Used | None. | None. | None |
| Amount Destroyed or Treated | None. | None. | None. |
| Reduction of Toxicity, Mobility, or Volume | None. | None. | None. |
| Irreversible Treatment | None. | None. | None. |
| Type and Quantity of Residuals Remaining After Treatment | No treatment. | No treatment. | Contaminant concentrations remaining in the soil at the site would be at or below acceptable levels (i.e., remedial goals). |
| Statutory Preference for Treatment | Does not satisfy the statutory preference for treatment. | Does not satisfy the statutory preference for treatment. | Partially satisfied because the soil will be treated off Base before disposal. |
| **Short-Term Effectiveness** | | | |
| Community Protection | Risk to community will remain the same as the baseline risk. Cumulative RME risk to a nonintrusive worker was estimated to be $1 \times 10^{-5}$. The corresponding RME risk to an intrusive worker was $6 \times 10^{-6}$. | No risk to community from planned institutional controls. | Temporary increase in potential risks due to dust emissions from soil handling, transportation, and treatment at off-base facility. |

Table 3-2

Site 1111 Summary of Detailed Analysis of Soil Alternatives
OU 5 FS, MCB Camp Pendleton, California

| NCP Criterion | Alternative 1111-S1 | Alternative 1111-S2 | Alternative 1111-S3 |
|---|---|---|---|
| | No Action | Institutional Controls | Soil Excavation, Backfill, and Off-Base Land Disposal |
| **Short-Term Effectiveness (continued)** | | | |
| Worker Protection | Not applicable because no remedial action will be implemented. | Limited protection would be required during site erosion control maintenance activities. | Protection would be required against potential inhalation of fugitive dust, dermal contact, and ingestion of impacted soil site soil during excavation, transportation and off-site disposal (use of PPE and dust suppressants). |
| Environmental Impacts | No impact from existing conditions. | No adverse environmental impact from institutional controls. | No significant adverse impacts to environment. Some short-term impacts to ecological receptors and habitats could occur. Affected area would be revegetated following completion of remedial actions. Close coordination with the appropriate regulatory agencies would be required. |
| Time Until Action Is Completed | Not applicable. | Continued site maintenance | 5 weeks. |
| **Implementability** | | | |
| Ability to Construct and Operate | No construction or operation is involved. | Land use restrictions and site maintenance are readily implementable. | Excavation, stabilization, and disposal are readily implementable. |
| Ease of Doing More Action if Needed | Because no action is involved, there will be no interference with future actions. | Soil remedial actions can easily be implemented, if required in the future. | Soil remedial actions can easily be implemented, if required in the future. |
| Ability to Monitor Effectiveness | Not applicable because no remedial action will be implemented. | Site will be periodically monitored for erosion control. Land use control measures will be enforced. | Effectiveness will be monitored through confirmation sampling and analysis during excavation. |

Table 3-2

**Site 1111 Summary of Detailed Analysis of Soil Alternatives**
**OU 5 FS, MCB Camp Pendleton, California**

| NCP Criterion | Alternative 1111-S1 | Alternative 1111-S2 | Alternative 1111-S3 |
|---|---|---|---|
| | **No Action** | **Institutional Controls** | **Soil Excavation, Backfill, and Off-Base Land Disposal** |
| **Implementability (continued)** | | | |
| Ability to Obtain Approvals and Coordinate with Other Agencies | No approval is necessary. | No approval is necessary. | Manifests will be required for transportation of wastes. Off-base facility has existing permits for treatment and disposal. Would require coordination with and approval from USFWS to ensure protection of ecological receptors during excavation activities. |
| Availability of Services and Capacities | Not applicable. | Services are available for the proposed institutional controls. | Services are commercially available for the excavation/earthwork and off-base disposal. |
| Availability of Equipment, Specialists, and Materials | Not applicable. | All services require commercially available standard equipment and machinery. | All services require commercially available standard equipment and machinery. |
| Availability of Technologies | Not applicable. | All technologies are proven and available. | All technologies are proven and available. |
| **Cost** | | | |
| Overall Cost | $0 | $295,000 | $711,400 |

Table 3-3
Site 1111 - Alternative 1111-G2 Institutional Controls And Long-Term Monitoring
Initial Long-Term Monitoring Well Network

| Target Monitoring Zones | Description | Initial Monitoring Locations | Performance Monitoring Objectives | Monitoring Parameters | Monitoring Frequency |
|---|---|---|---|---|---|
| **Baseline Sampling** | All existing Site 1111 wells | - Existing wells 1111MW-1, 1111MW-2, 1111MW-4, 1111MW-5, 1111MW-6, 1111MW-35A, 1111MW-35B.<br>- New well in the source area to replace unusable well 1111MW-3 | - Establish a baseline to actualize site conditions and confirm that plume is stable and not migrating.<br>- Evaluate baseline sampling to determine list of selected wells, if any, for plume monitoring. | - VOCs | - Semi annually for first year only. |
| **Plume Monitoring** | Selected wells based on Site conditions | - Initially existing wells 1111MW-4, 1111MW-5, 1111MW-6 and new well at 1111MW-3.<br>- Dynamic list to be determined every year based on site conditions. | - Track plume behavior to evaluate site conditions.<br>- Modify monitoring well network to add or drop plume-tracking ells based on changing site conditions. | - VOCs | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5 |
| **Sentry Wells** | Designated early warning points between plume boundaries and possible receptors. | - New well 200 ft. east of well 1111MW-5 | - Verify that VOC concentrations are below RGs.<br>- Detect unacceptable plume migration or impact to receptors which requires implementation of contingency actions. | - VOCs | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5. |
| **Groundwater Hydrology** | All existing Site 1111 wells | - Entire IC&LTM GW monitoring network (9 wells) | - Determine that there are no changes in groundwater flow rates and directions that would impact plume stability.<br>- Estimate hydraulic gradients. | - Groundwater elevations. | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5. |
| **Summary** | | **- 7 Existing wells**<br>**- 2 New wells** | | | |

Table 3-4
Site 1111 - Alternative 1111-G3 Monitored Natural Attenuation
Initial MNA Monitoring Well Network

| Target Monitoring Zones | Description | Monitoring Locations | Performance Monitoring Objectives | Monitoring Parameters | Monitoring Frequency |
|---|---|---|---|---|---|
| **Baseline Sampling** | All existing Site 1111 wells | - Existing wells 1111MW-1, 1111MW-2, 1111MW-4, 1111MW-5, 1111MW-6, 1111MW-35A, and 1111MW-35B.<br>- New well in the source area to replace unusable well 1111MW-3. | - Establish a baseline to actualize site conditions and confirm that plume is stable and not migrating.<br>- Evaluate baseline sampling results to determine the need for any modifications to the initial MNA monitoring network. | - VOCs<br>- Geochemical parameters. | - Semi annually for first year only. |
| **Hot Spots / Recalcitrant Zone** | Areas of highest or persistent VOC concentrations | - New source area well to replace unusable well 1111MW-3. | - Estimate VOC reduction over time.<br>- Estimate source mass dissolution rate.<br>- Determine need for additional remedial action to reduce VOC concentrations to desired levels. | - VOCs<br>- Geochemical parameters. | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5. |
| **Plume Centerline** | Areas of high concentration and mobility along plume core flowpaths. | - Flowpath 1: New source area well ==> New intermediate well immediately downgradient of source area (1) ==> 1111MW-4 ==> 1111MW-6. | - Estimate reduction of VOC plume over time and distance (i.e., NA rate, decay rate)<br>- Calculate reductions in VOC mass and concentrations. | - VOCs<br>- Geochemical parameters. | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5. |
| **Plume Boundaries/ Sentry Wells** | Areas sidegradient and downgradient outside plume. Designated points of compliance between plume boundaries and possible receptors. | - New well 200 ft. east of well 1111MW-5. | - Detect unacceptable plume expansion and changes in groundwater flow direction. | -VOCs | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5. |
| **Background** | Areas upgradient, sidegradient or downgradient of the VOC plume, representative of uncontaminated geochemical settings. | - New well upgradient of 1111MW-2. | - Determine variability of geochemical conditions outside VOC plume.<br>- Measure geochemical setting. | - VOCs<br>- Geochemical parameters. | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5. |
| **Groundwater Hydrology** | All Site 1111 areas. | - Entire GW MNA monitoring network (11 wells) | - Determine that there are no changes in groundwater flow rates and directions that would impact plume stability.<br>- Estimate hydraulic gradients. | - Groundwater elevations. | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5. |
| **Summary** | | **- 7 Existing wells**<br>**- 4 New wells** | | | |

Table 3-5

Site 1111 Summary of Detailed Analysis of Groundwater Alternatives
OU 5 FS, MCB Camp Pendleton, California

| NCP Criterion | Alternative 1111-G1<br>No Action | Alternative 1111-G2<br>Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3 | Alternative 1111-G3<br>Monitored Natural Attenuation with Alternative 1111-G2 | Alternative 1111-G4<br>Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3 |
|---|---|---|---|---|
| **Overall Protection of Human Health and the Environment** | | | | |
| Human Health Protection | No reduction in baseline risks. No control of exposure pathways. Not protective of human health. | Reduces potential risks from groundwater ingestion or dermal absorption by limiting access to groundwater and conducting periodic monitoring. Protective of human health. | Reduces potential risks from groundwater ingestion or dermal absorption by limiting access to groundwater and conducting periodic monitoring. Long-term risk would be reduced as the contaminant concentrations naturally attenuate over time. Protective of human health. | Reduces baseline risks through treatment. Reduces potential risks from groundwater ingestion or dermal absorption by limiting access to groundwater and conducting periodic monitoring. Additional protection of human health would result from more rapid attainment of MCLs or background levels. Protective of human health. |
| Environmental Protection | Local habitat not impacted by current conditions. No current environmental threats to threatened or endangered species. Existing groundwater contamination would remain in the short term and reduced over time by natural attenuation. Protective of the environment. | Local habitat not impacted by current conditions. No current environmental threats to threatened or endangered species. Existing groundwater contamination would remain in the short term and be reduced over time by natural attenuation. Protective of the environment. | Local habitat not impacted by current conditions. No current environmental threats to threatened or endangered species. Existing groundwater contamination would remain in the short term and be reduced over time by natural attenuation. Protective of the environment. | Local habitat not impacted by current conditions. No current environmental threats to threatened or endangered species. Enhanced bioremediation would reduce groundwater contamination through treatment in a shorter time. Protective of the environment. |
| **Compliance with ARARs** | | | | |
| Chemical-Specific ARARs | Would not meet groundwater standards in the short-term. Concentrations expected to remain indefinitely if source is not removed. | Expected to meet groundwater ARARs within 3 to 5 years. | Expected to meet groundwater ARARs within 3 to 5 years. | Expected to meet groundwater ARARs within 3 to 5 years. |
| Location-Specific ARARs | None. | None. | None. | None. |
| Action-Specific ARARs | Does not meet action-specific ARARs of monitoring. | Meets all action-specific ARARs. | Meets all action-specific ARARs. | Meets all action-specific ARARs. |

Table 3-5

Site 1111 Summary of Detailed Analysis of Groundwater Alternatives
OU 5 FS, MCB Camp Pendleton, California

| NCP Criterion | Alternative 1111-G1 | Alternative 1111-G2 | Alternative 1111-G3 | Alternative 1111-G4 |
|---|---|---|---|---|
| | No Action | Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3 | Monitored Natural Attenuation with Alternative 1111-G2 | Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3 |
| **Long-Term Effectiveness and Permanence** | | | | |
| Magnitude of Residual Risk<br>• Groundwater ingestion or dermal absorption by future users | Does not limit long-term exposure. | Limits long-term exposure by restricting groundwater use. | Limits long-term exposure by restricting groundwater use. | Effectively and permanently limits long-term exposure by treating VOCs and restricting groundwater use. |
| Adequacy and Reliability of Controls | Provides no reliable or adequate controls. | Provides adequate and reliable controls to reduce long-term risks through access restriction. | Provides adequate and reliable controls to reduce long-term risks through monitoring and access restriction. | Provides adequate and reliable controls to reduce long-term risks through monitoring, access restriction, and treatment. |
| Need for 5-Year Review | No review would be done. | Review would be required to confirm the plume is not migrating off site. | Review would be required to monitor the effectiveness of natural attenuation processes. | Review would be required to evaluate the effectiveness of the enhanced bioremediation and natural attenuation processes. |
| **Reduction of Toxicity, Mobility, or Volume Through Treatment** | | | | |
| Treatment Process Used | None. | None. | None. | VOC degradation via enhanced bioremediation. |
| Amount Destroyed or Treated | None. | None. | None. | 0.55 kg |
| Reduction of Toxicity, Mobility, or Volume | Natural attenuation. | Natural attenuation. | Natural attenuation. | Natural attenuation. Reduced toxicity, mobility, and volume by accelerated biodegradation. |
| Irreversible Treatment | None. | None. | None. | Yes. VOCs are destroyed. |
| Type and Quantity of Residuals Remaining After Treatment | No groundwater treatment. | No groundwater treatment. | No groundwater treatment. | Contaminant concentrations remaining in the groundwater would be at or below acceptable levels (i.e., remedial goals). |
| Statutory Preference for Treatment | Does not satisfy the statutory preference for treatment. | Does not satisfy the statutory preference for treatment. | Does not satisfy the statutory preference for treatment. | Satisfies the statutory preference for treatment. |

Table 3-5

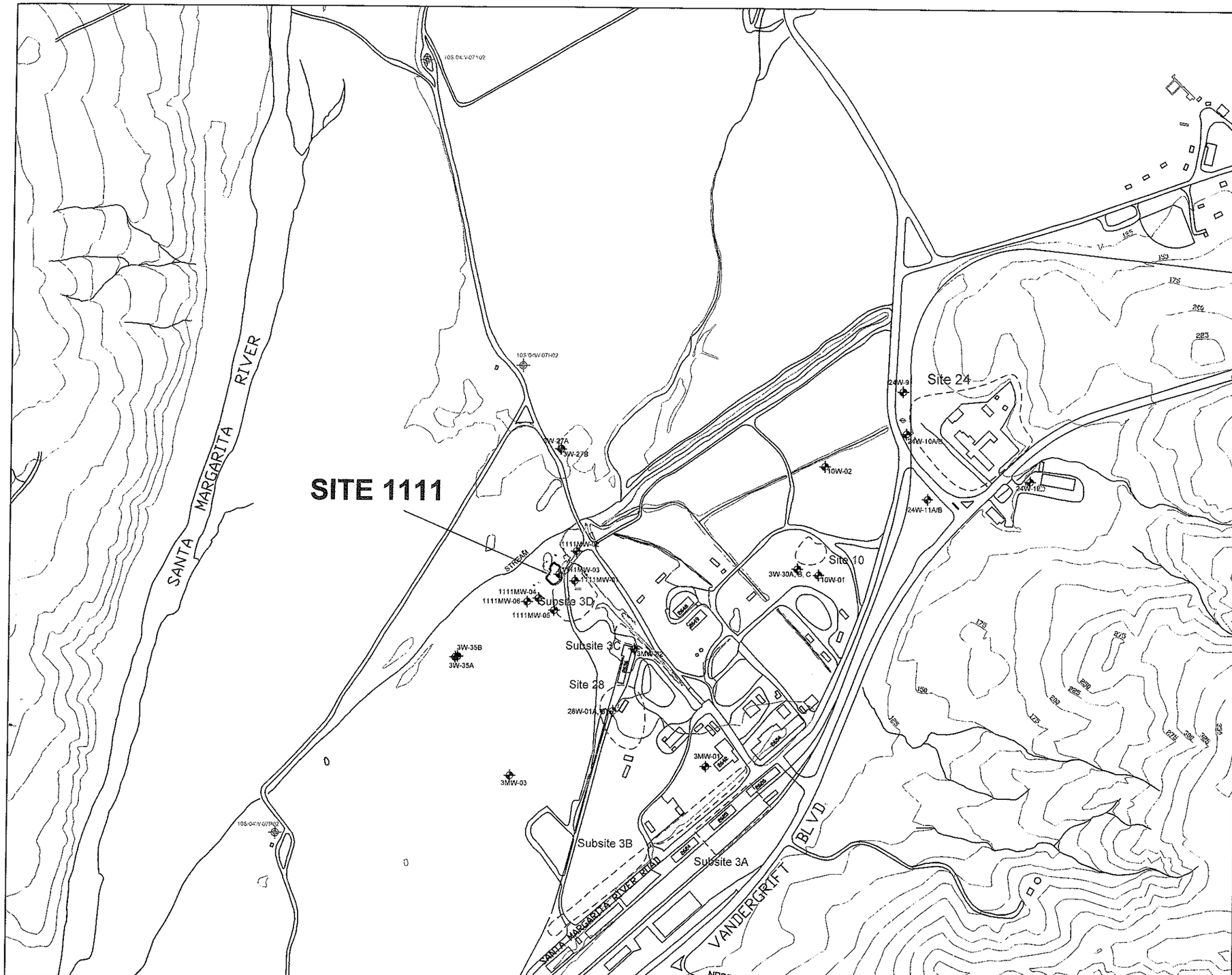
Site 1111 Summary of Detailed Analysis of Groundwater Alternatives
OU 5 FS, MCB Camp Pendleton, California

| NCP Criterion | Alternative 1111-G1 | Alternative 1111-G2 | Alternative 1111-G3 | Alternative 1111-G4 |
|---|---|---|---|---|
| | No Action | Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3 | Monitored Natural Attenuation with Alternative 1111-G2 | Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3 |
| **Short-Term Effectiveness** | | | | |
| Community Protection | Zero incremental risk because no remedial action would be implemented. | Short-term risk to the community would not be increased by this remedial action. | Short-term risk to the community would not be increased by this remedial action. | Short-term risk to the community would not be increased by this remedial action. |
| Worker Protection | Not applicable because no remedial action would be implemented. | Potential short-term risks to site workers associated with dust emissions and direct contact with contaminated groundwater during well construction. PPE would be used during construction and sampling activities. | Potential short-term risks to site workers associated with dust emissions and direct contact with contaminated groundwater during well construction. PPE would be used during construction and sampling activities. | Potential short-term risks to site workers associated with dust emissions and direct contact with contaminated groundwater during well construction and implementation of enhanced bioremediation system. PPE would be used during construction and sampling activities. |
| Environmental Impacts | None. Continued impact from existing conditions. | None. Continued impact from existing conditions. | None. Continued impact from existing conditions. | None. Areas disturbed by implementing this alternative will be revegetated upon completion of the treatment system construction. Mitigates current groundwater conditions. |
| Time Until Action Is Completed | None. No action is taken. | MCLs: 3.4 years.<br>Background levels: 4.9 years | MCLs: 3.4 years.<br>Background levels: 4.9 years | MCLs: 2.6 years.<br>Background levels: 4.1 years |
| **Implementability** | | | | |
| Ability to Construct and Operate | No construction or operation is involved. | Land-use controls to restrict future access to groundwater are easy to implement. Monitoring wells are easy to construct, sample, and maintain. | Monitoring wells are easy to construct, sample, and maintain. | Construction of enhanced bioremediation system involves common, proven, and reliable methods and practices. |
| Ease of Doing More Action if Needed | Because no action is involved, there would be no interference with future actions. | Land-use controls and groundwater sampling could be easily implemented. | Additional groundwater monitoring wells or treatment could be easily implemented. | Expansion/Contraction of enhanced bioremediation system can be easily implemented. |

Table 3-5

Site 1111 Summary of Detailed Analysis of Groundwater Alternatives
OU 5 FS, MCB Camp Pendleton, California

| NCP Criterion | Alternative 1111-G1<br>No Action | Alternative 1111-G2<br>Institutional Controls and Long-Term Groundwater Monitoring with Alternative 1111-S3 | Alternative 1111-G3<br>Monitored Natural Attenuation with Alternative 1111-G2 | Alternative 1111-G4<br>Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3 |
|---|---|---|---|---|
| **Implementability (continued)** | | | | |
| Ability to Monitor Effectiveness | Not applicable because no remedial action would be implemented. | Effectiveness would be monitored through well sampling and analysis. | Effectiveness would be monitored through well sampling and analysis. | Effectiveness would be monitored through sampling and analysis of monitoring wells. |
| Ability to Obtain Approvals and Coordinate with Other Agencies | No approval is necessary. | Well permits are required for new wells. | Well permits are required for new wells. | Well permits are required for new wells. |
| Availability of Services and Capacities | Not applicable. | Monitoring well equipment is commercially available. | Monitoring well equipment is commercially available. | Enhanced bioremediation and monitoring equipment is commercially available. |
| Availability of Equipment, Specialists, and Materials | Not applicable. | Monitoring equipment and personnel are commercially available. | Monitoring equipment and personnel are commercially available. | Enhanced bioremediation uses widely available equipment, materials, and labor, and is easily implementable. |
| Availability of Technologies | Not applicable. | Technology proven and available. | Technology proven and available. | Technology is innovative and available; a pilot test would be conducted. |
| **Cost** | | | | |
| Capital Cost | $0 | $110,000 | $160,600 | $199,500 |
| Cumulative O&M Cost | $0 | MCLs: $75,000<br>Background: $86,100 | MCLs: $107,100<br>Background: $145,600 | MCLs: $107,100<br>Background: $145,600 |
| Total Cost | $0 | MCLs: $185,000<br>Background: $196,100 | MCLs: $267,700<br>Background: $306,200 | MCLs: $306,600<br>Background: $345,100 |

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**Legend**

- Approximate Extent of Contamination Based on Field Observations and Analytical Data
- Former IR Site
- Groundwater Monitoring Well
- Base Water Supply Well

N

0 500 1000

Scale in Feet

**Figure 3-1**

**Site 1111**
**Site Location Map**

MCB Camp Pendleton, California

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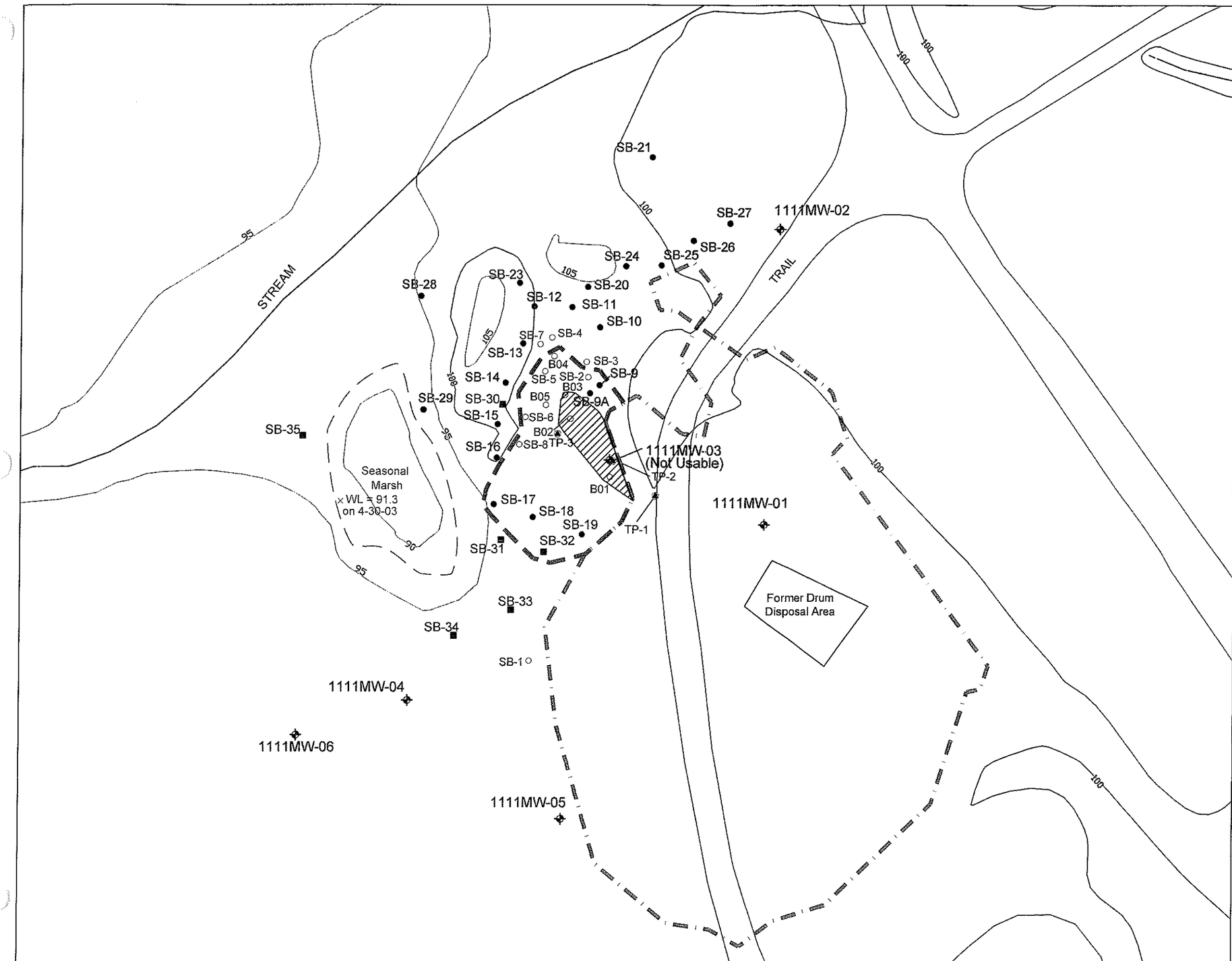


## Legend

- Approximate Extent of Contamination Based on Field Observations and Analytical Data
- Approximate Area of Group A, Site 3 Non-Time Critical Removal Action (OHM, 1997b)
- Burn Area
- Soil Boring (OU 4 RI, 1998)
- Temporary Well (OU 4 RI, 1998)
- Soil Boring (OU 5 RI, 2001)
- Soil Boring (OU 5 RI, 2003)
- Groundwater Monitoring Well

N

0 50 100

Scale in Feet

**Figure 3-2**

**Site 1111**
**Groundwater Monitoring Well and Soil Boring Locations**

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| Soil General Response Actions | Remedial Technology | Process Options | Description | Screening Comments |
|---|---|---|---|---|
| No Action | None | None | No action is taken. | Required for consideration by NCP. |
| Institutional Control | Access Restrictions | Use Restrictions/Fencing | Administrative/physical measures are taken to limit site access and use and secure the site. | Potentially applicable. Only partially effective for ecological receptors. |
| Containment | Capping | Asphalt Cap | Single-layer bituminous asphalt surface cover is placed over site. | Not applicable due to site conditions. |
| | | Concrete Cap | Single-layer concrete cover composed of aggregate and cementitious mixtures is placed over site. | Not applicable due to site conditions. |
| | | Engineered Soil Cover | Single- or multi-layered soil cover designed to required performance standards. | Not applicable due to site conditions. |
| Removal | Excavation | Mechanical Excavation | Contaminated soil is excavated using heavy equipment. | Potentially applicable. |
| Disposal | Land Disposal | Backfilling | Treated soil is used as a backfill for the excavated site area. | Not applicable due to site conditions. |
| | | On-Base Landfilling | Contaminated soil is transported to an on-Base landfill. | Not applicable. No on-Base landfill available. |
| | | Off-Base Landfilling | Contaminated soil is transported to a permitted off-Base disposal facility. | Potentially applicable. |

Process Option Screened Out During Initial Screening

**Figure 3-3**

**Site 1111**
**Initial Screening of Technologies for Soil**
**(Page 1 of 2)**

MCB Camp Pendleton, California

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| Soil General Response Actions | Remedial Technology | Process Options | Description | Screening Comments |
|---|---|---|---|---|
| In Situ Treatment | Physical/Chemical | Soil Flushing | Flushes contaminants out of soil via injection or infiltration of water or aqueous solution. Groundwater collection and treatment required. | Not readily implementable. Degrades groundwater where it is not currently a concern. |
| | | Solidification/Stabilization | Chemical reagents are mechanically mixed with soil matrix to reduce the toxicity and mobility of metals. | Not effective for site conditions. |
| | | In Situ Vitrification | Soil waste is heated to the melting point through electrically-charged probes; glassy monolith results. | Difficult to implement and impractical for site conditions. |
| | Biological | Phytoremediation | Plants are used to extract contaminants from shallow soils. | Not effective for metals and depth of contamination. |
| Ex Situ Treatment | Physical/Chemical | Soil Washing | Water-based waste removal process. Water can be augmented with surfactant, leaching agent, or chelating agent. | Not effective for site conditions. |
| | | Acid Extraction | Metals are solubilized and removed from the soil using acidic reagents (i.e. hydrochloric acid). | Not very effective for metals and difficult to implement. |
| | | Solidification/Stabilization | Chemical reagents are mixed with excavated soil to reduce the toxicity and mobility of metals. | Not effective for site conditions (i.e. abundant anthropogenic debris in impacted soils). |
| | | Vitrification | Excavated soil is heated to the melting point through electrical power to form stable glass and crystalline structure. | Difficult to implement and impractical for site conditions. |
| | Thermal | Thermal Desorption | Uses heat in a controlled environment to desorb and remove contaminants from the soil. | Not effective for metals. |
| | | Incineration | Contaminated soil is burned in a controlled environment to remove organic contaminants. | Not effective for metals. |

Process Option Screened Out During Initial Screening

**Figure 3-3**

**Site 1111**
**Initial Screening of Technologies for Soil**
**(Page 2 of 2)**

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| Soil General Response Actions | Remedial Technology | Process Options | Effectiveness Rating | Implementability Rating | Cost Rating |
|---|---|---|---|---|---|
| No Action | None | None | Low; contaminants would remain in the soil. Both human and ecological receptors could be exposed. RAOs are not achieved. | High; no action is needed. | High; there are no costs. |
| Institutional Control | Access Restrictions | Use Restrictions/Fencing | Moderate; contaminants would remain in the soil. Effective to reduce human exposure but not protective of ecological receptors. | Moderate; readily implementable. DON position is to limit the use of institutional controls to maximize the use of military training lands. | High; low capital and O&M costs. |
| Removal | Excavation | Mechanical Excavation | High; removes contaminated soil and backfills excavation with clean soil. Demonstrated ability to meet RAOs but without treatment; does not reduce contaminant toxicity, mobility, or volume. | Moderate to high; readily implementable. Requires agency approval, Base coordination, and H&S planning. | Moderate; high capital costs, low O&M costs. |
| Disposal | Land Disposal | Off-Base Landfilling | High; demonstrated ability to meet RAOs but without treatment; does not reduce contaminant toxicity, mobility, or volume. | High; readily implementable. Landfilling of hazardous waste viewed unfavorable; increasingly difficult and expensive option. | Moderate; high capital costs, low O&M costs. |

**Figure 3-4**

**Site 1111**
**Evaluation of Process Options for Soil**

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| Groundwater General Response Actions | Remedial Technology | Process Options | Description | Screening Comments |
|---|---|---|---|---|
| No Action | None | None | No action is taken. | Required for consideration by NCP. |
| Institutional Control | Use Restrictions | Use Restrictions | Restrict use of groundwater in the contaminated area. | Potentially applicable. |
| | Well Head Treatment | Ex situ Treatment at Extraction Well Point | Install wellhead treatment unit for water supply wells impacted by contamination. | Potentially applicable. |
| | Monitoring | Periodic Sampling of Groundwater MWs | Periodic groundwater monitoring is conducted. | Potentially applicable. |
| | | Monitored Natural Attenuation | Natural processes are allowed to reduce contaminant concentrations to acceptable levels. | Potentially applicable. |
| | Alternate Water Supply | City Water Supply | Connect affected users to city water supply. | Not applicable due to relative isolation of Base from any cities. |
| | | New On-Base Supply Well | Install new water supply well in areas not impacted by the contamination. | Not applicable due to site conditions. |
| Containment | Structural Barriers | Slurry Wall | Impermeable soil (or cement) bentonite barrier built in flowpath of contaminant. | Not applicable due to site conditions. |
| | | Grout Curtain | Pressure injected grout in a regular pattern of drilled holes. | Not applicable due to site conditions. |
| | | Sheet Piling | Steel sheets permanently driven into the ground to create impermeable wall. | Not applicable due to site conditions. |
| | | Vibrating Beam Wall | I-beams driven into ground to desired depth and cavity filled with grout. | Not applicable due to site conditions. |
| | Hydraulic Barriers | Groundwater Pumping | Adjustment of groundwater levels through pumping to control plume migration. | Not applicable due to site conditions. |
| | Subsurface Drains | Interceptor Trench | Perforated pipes in trenches intercepting plume; collect contaminated groundwater. | Not applicable due to site conditions. |

Process Option Screened Out During Initial Screening

**Figure 3-5**

**Site 1111**
**Initial Screening of Technologies for Groundwater**
**(Page 1 of 4)**

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| Groundwater General Response Actions | Remedial Technology | Process Options | Description | Screening Comments |
|---|---|---|---|---|
| Extraction/Removal | Groundwater Pumping | Extraction Wells | Groundwater pumping using individual extraction wells. | Not applicable for the site conditions. |
| | | Well Points | Groundwater pumping using matrix of driven wells connected to single pump. | Not applicable for the site conditions. |
| | | Dual Phase Extraction | High vacuum liquid/vapor treatment system designed to remove contaminants from above and below the water table. | Not applicable for the site conditions. |
| Discharge | Surface Discharge | On-Base w/o Treatment | Extracted untreated groundwater discharged to on-Base Stream. | Not applicable for the site conditions. |
| | | On-Base w/ Treatment | Extracted treated groundwater discharged to on-Base stream. | Not applicable for the site conditions. |
| | | Off-Base w/ or w/o Treatment | Extracted groundwater discharged to off-Base stream or Pacific Ocean. | Not applicable for the site conditions. |
| | Treatment Plant | On-Base Facility | Extracted untreated groundwater discharged to on-Base treatment plant. | Not applicable. On-Base facility cannot effectively treat solvents. |
| | | Publically Owned Treatment Works | Extracted untreated groundwater discharged to POTW. | Not applicable. Nearest POTW facilities are limited to municipal sewage treatment. |
| | Subsurface Discharge | Injection Wells | Extracted untreated groundwater reinjected back into aquifer plume. | Not applicable for the site conditions. |
| In Situ Treatment | Physical | Air Sparging | Air or nitrogen is injected into groundwater to volatilize, collect, and treat VOC plume. | Not applicable for the site conditions. |
| | | In Well Air Stripping | Air or nitrogen is injected into groundwater to volatilize, collect, and treat VOC plume. | Not applicable for the site conditions. |

Process Option Screened Out During Initial Screening

**Figure 3-5**

**Site 1111**
**Initial Screening of Technologies for Groundwater**
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MCB Camp Pendleton, California

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| Groundwater General Response Actions | Remedial Technology | Process Options | Description | Screening Comments |
|---|---|---|---|---|
| In Situ Treatment (continued) | Chemical | Chemical Oxidation | Chemical reagents are injected into groundwater to destroy contaminants by converting them to innocuous compounds. | Not applicable for site conditions. |
| | | Permeable Reactive Barrier | Intercepting barrier packed with reactive material to remove contaminants from groundwater as it flows through barrier. | Not applicable for site conditions. |
| | | ZVI Treatment | Reactive material injected in source area to reduce contamination. | Not applicable for site conditions. |
| | Biological | Enhanced Bioremediation | A specific material is injected into the groundwater to promote biodegradation of contaminants. | Potentially applicable. |
| | | Phytoremediation | Uses plants to remove, transfer, stabilize, and destroy contamination in groundwater, surface water, and leachate. | Potentially applicable. |
| Ex Situ Treatment | Physical | Air Stripping | Volatile contaminants are stripped off by contacting groundwater with air in a high interfacial area system. | Potentially applicable; but no extracted groundwater and not needed at this time. |
| | | Liquid Phase Carbon Adsorbtion | Groundwater is pumped through one or more vessels containing activated carbon to which dissolved organic contaminants adsorb. | Potentially applicable; but no extracted groundwater and not needed at this time. |
| | | Membrane Separation | Separates contaminants from their medium by preventing them from passing through semipermeable membrane. | Not applicable. |
| | | Flow Equalization | Interaction between groundwater from various sources to equalize variations. | Potentially applicable as a support technology; but no extraction retained. |
| | | Sedimentation | Solids removal via pH adjustment, chemical addition, coagulation, or flocculation. | Potentially applicable as a support technology; but no extraction retained. |
| | | Filtration | Removal of suspended solids by forcing solution through porous a medium. | Potentially applicable as a support technology; but no extraction retained. |
| | | Liquid-Liquid Extraction | | Not applicable for the site conditions. |

Process Option Screened Out During Initial Screening

**Figure 3-5**

**Site 1111**
**Initial Screening of Technologies for Groundwater**
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MCB Camp Pendleton, California

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| Groundwater General Response Actions | Remedial Technology | Process Options | Description | Screening Comments |
|---|---|---|---|---|
| Ex Situ Treatment (continued) | Chemical | Ion Exchange | Ions on a solid-phase medium selectively swap with ionic contaminants in the groundwater facilitating removal. | Not applicable for site contaminants. |
| | | Chemical Precipitation | Precipitation of contaminants via chemical reaction. | Not applicable for site contaminants. |
| | | Oxidation-Reduction | Raising or lowering oxidation state of compound via chemical addition. | Not applicable for site contaminants. |
| | | Chemical Dechlorination | Use of chemical reactions to dehalogenate chlorinated compounds. | Not applicable for site conditions. |
| | | Coagulation/Flocculation | Reagents added to neutralize surface charges of fine contaminant particles, entrapping them and facilitating removal. | Not applicable for site conditions. |
| | | Coprecipitation | Removal of ionic compounds via adsorbtion onto another precipitating solid. | Not applicable for site contaminants. |
| | | U/V Oxidation | Destroying organic contaminants via simultaneous application of ultraviolet light and strong oxidizer. | Not applicable for site conditions. |
| | Biological | Fixed-Film Bioreactor | Biomass attached to inert support media is used to degrade organics in groundwater. | Not applicable for site contaminants. |
| | | Suspended Growth Bioreactor | Bacteria in suspension in aqueous media is aerated in a tank to degrade organics and create new bacteria. | Not applicable for site contaminants. |

Process Option Screened Out During Initial Screening

Figure 3-5

Site 1111
Initial Screening of Technologies for Groundwater
(Page 4 of 4)

MCB Camp Pendleton, California

PARSONS

Pasadena, California

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| Groundwater General Response Actions | Remedial Technology | Process Options | Effectiveness Rating | Implementability Rating | Cost Rating |
|---|---|---|---|---|---|
| No Action | None | None | Low; does not achieve RAOs or proposed remediation goals. | High; no action is needed. | High. |
| Institutional Control | Use Restrictions | Use Restrictions | Low to Moderate; contamination is not reduced. Effectiveness to reduce risk depends on continued future implementation. | High; readily implementable. | High. |
| | Well Head Treatment | Ex situ Treatment at Extraction Well Point | Low; contamination has not been detected in production wells. | High; readily implementable. | Low. |
| | Monitoring | Periodic Sampling of Groundwater MWs | Moderate; effective for monitoring plume size and concentrations and for early warning of contaminant migration. | High; monitoring network already exists; potentially acceptable to agencies because of low contaminant concentrations and absence of current receptors. | Moderate to High. |
| | | Monitored Natural Attenuation | Moderate; method is reliable and proven. If implemented alone it is a long-term process. | High; additional wells can be easily installed; potentially acceptable to agencies because of low contaminant concentrations and absence of current receptors. | Moderate. |
| In Situ Treatment | Biological | Enhanced Bioremediation | Moderate to High; VOCs in groundwater may support adequate microbial activity and reduce natural attenuation time frame; no receptors or downgradient wells that require protection. | High; materials and equipment readily available. | Low to Moderate. |
| | | Phytoremediation | Low to Moderate; due to uncertainties in root uptake, growth rate, and field data, the overall effectiveness of this alternative is likely to vary. | Moderate; materials readily available; non-native species introduced to ecologically sensitive habitat. | Moderate. |

Process Option Screened Out During Evaluation

**Figure 3-6**

**Site 1111**
**Evaluation of Process Options for Groundwater**

MCB Camp Pendleton, California

**PARSONS**

Pasadena, California

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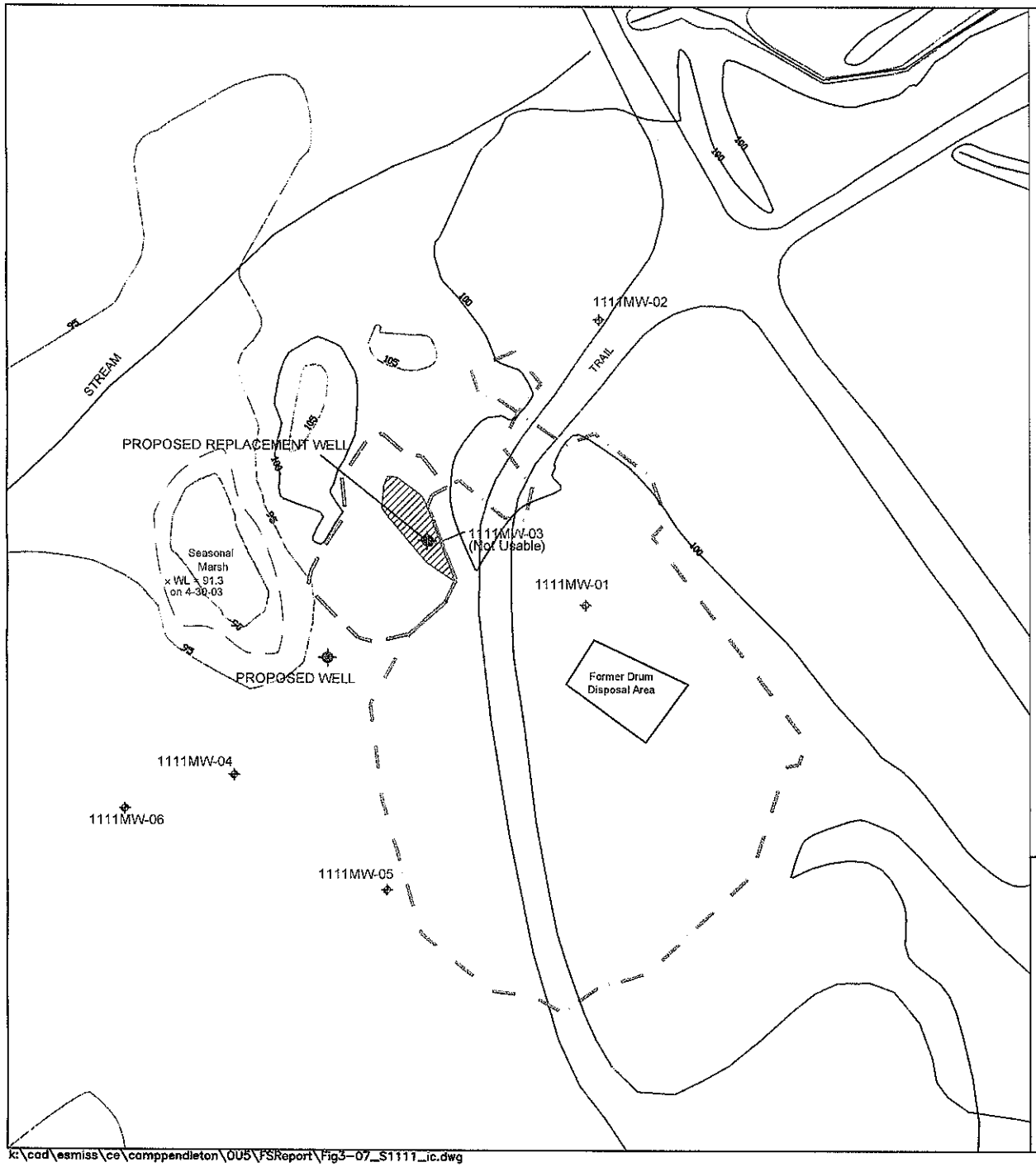


## Legend

- Approximate Extent of Contamination Based on Field Observations and Analytical Data
- Approximate Area of Group A, Site 3 Non-Time Critical Removal Action (OHM, 1997b)
- Burn Area
- Groundwater Monitoring Well Not Included in Initial Long Term Monitoring Network
- Groundwater Monitoring Well Included in Initial Long Term Monitoring Network
- Proposed Groundwater Monitoring Well Included in Long Term Monitoring Network

N

0 100 200

Scale in Feet

# Figure 3-7

## Site 1111
## Proposed Monitoring Network for Institutional Controls and Groundwater Monitoring

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

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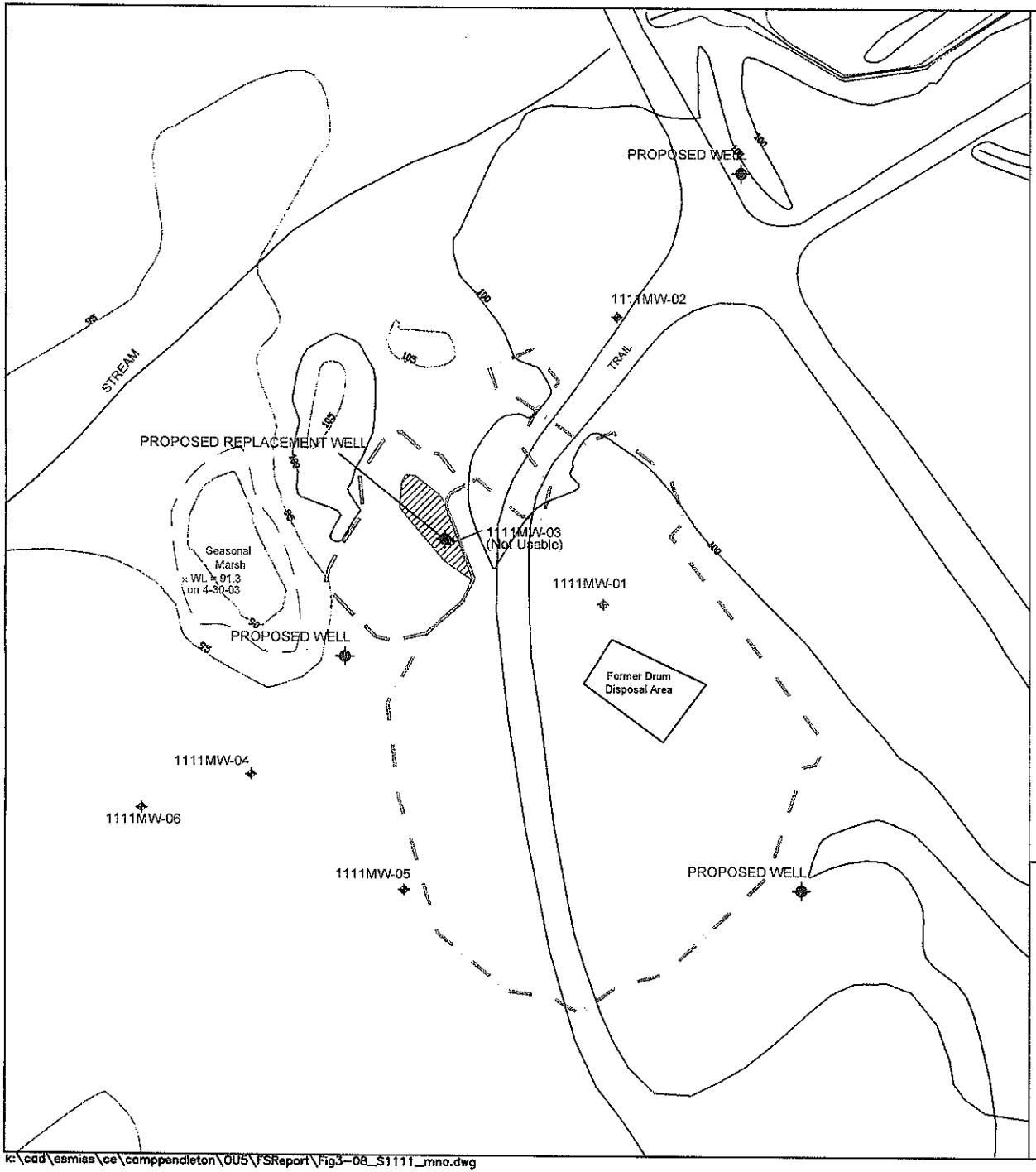


## Legend

- Approximate Extent of Contamination Based on Field Observations and Analytical Data
- Approximate Area of Group A, Site 3 Non-Time Critical Removal Action (OHM, 1997b)
- Burn Area
- Groundwater Monitoring Well Included in Initial Long Term Monitoring Network
- Proposed Groundwater Monitoring Well Included in Long Term Monitoring Network

N

0 80 160

Scale in Feet

**Figure 3-8**

**Site 1111**
**Proposed Monitoring Network for MNA**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

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## 4.0 12 AREA

The 12 Area, Site 13 is located in the eastern portion of MCB Camp Pendleton, approximately three miles southwest of the northeastern Base entrance (Figure 4-1), and approximately 500 feet west-southwest of the intersection of Vandergrift Blvd. and 19th Street Site 13 is currently undeveloped except for a segment of paved road (Figure 4-2). The site is vegetated with low-lying grasses and several trees on the eastern portion.

### 4.1 Background Information

Although this FS provides a summary of site conditions, it does not repeat all the information provided in previous documents regarding detailed site descriptions, histories, regional and site-specific environmental information, or results of previous investigations and risk assessments. This information is incorporated by reference as appropriate and is documented in the following reports:

- Subsurface Storage Tank Investigation Report (Westec Services, December 22, 1986)
- Cleanup and Abatement Order (CAO) No. 88-51 and Addendum No. 1 to CAO No. 88-51 (RWQCB, San Diego Region, 1988 and 1992)
- Baseline Groundwater Monitoring Report (IT, 1995)
- Final Site Assessment Report, 12 and 13 Areas (IT, 1996)
- CAO No. 96-49 (RWQCB, San Diego Region, July 1996b)
- 12 and 13 Areas – First Quarter Groundwater Monitoring Report (SWDIV, 1997b)
- 12 and 13 Areas – Second Quarter Groundwater Monitoring Report, Marine Corps Base, Camp Pendleton, California (SWDIV, 1997c)
- Underground Storage Tank Sites, 12 and 13 Areas, Marine Corps Base, Camp Pendleton, California (OHM, 1997a)
- 12 and 13 Areas – First 1998 Semiannual Groundwater Monitoring Report, Marine Corps Base, Camp Pendleton, California (SWDIV, 1998)
- Annual Groundwater Monitoring Report, 12 and 13 Areas, Marine Corps Base, Camp Pendleton, California (Parsons, 1998)
- Annual Groundwater Monitoring Report, 12 and 13 Areas (Parsons, 1999b)
- Semiannual Groundwater Monitoring Report for April 2000 to September 2000, 12 and 13 Areas (SWDIV, 2000)
- Final Groundwater Sampling Plan for Multiple 12 and 13 Area Sites, Marine Corps Base Camp Pendleton (Foster Wheeler, 2001a)
- Final First Semiannual 2001 Groundwater Monitoring Report for Site 13, 12 Area (Foster Wheeler, 2001b)
- Draft Final OU 5 RI Field Sampling Plan for Sites 21, 33, 1111, 1A-1, 6A, and 12/13 Area (Parsons, 2001)

- Final 2001 Annual Groundwater Monitoring Report for Site 13, 12 Area (Foster Wheeler, 2001c)
- Final Soil Investigation Work Plan for Multiple 12 and 13 Area Sites, MCB Camp Pendleton, Revision 1 (Foster Wheeler, 2002)
- Draft Final Operable Unit 5, Field Sampling Plan Addendum for Sites 1A-1, 6A, 21, 33, 1111, 12 Area, 13 Area and 22/23 Area Groundwater (Parsons, 2003b)
- Draft Final Remedial Investigation Report for OU 5 Sites 1A-1, 6A, 21, 1111, and 12 Area (Site 13) (Parsons, 2004).

### 4.1.1 Site Description and History

The 12 Area, Site 13 was formerly managed under the Base UST Program. As documented in the FFA Meeting Minutes for the 29 August 2000 meeting (No. 59), it was decided that due to the presence of VOCs in groundwater at the site, it would be addressed under the CERCLA program in OU 5. The site was designated as an IR site requiring additional data and placed in OU 5 to determine if soil and/or groundwater contaminants pose a significant risk to human health or the environment.

The 12 Area, Site 13 is located at the former location of Buildings 1280 and 1283. UST 13, which was associated with Building 1283 and removed prior to 1994, was a 1,500-gallon concrete tank used to store diesel fuel for heating. Former Building 1283 was a mess hall and former Building 1280 was a Quonset hut used for food storage. These buildings were demolished in November 1992, which is the same year Building 12052 was built. Nothing previously was located in the area now occupied by Building 12052 (MCB Camp Pendleton, 2002). The site appears undeveloped in the 1928 aerial photograph, but by 1953, former Building 1283 is visible and very little changed in the 1970 and 1979 aerial photographs (Parsons, 2004).

An office building, Building 12052, and a large parking area are located to the west of 12 Area, Site 13 (Figure 4-2). A roadway is located on the west boundary of Site 13. Another parking area is located to the east of Site 13. The groundwater production wells closest to the site are located over 10,000 feet downgradient to the west within the Santa Margarita River basin, near Site 1111. The site is over 1 mile outside the Santa Margarita River basin and is over two miles east of the nearest water supply wells in 26 Area. The site is located approximately one mile southeast of Lake O'Neill, which is within the upper subbasin of the Santa Margarita River basin.

### 4.1.2 Environmental Setting

This section includes a brief description of site topography, surface water, geology, hydrogeology, and ecology, which are described in more detail in the OU 5 RI (Parsons, 2004).

#### 4.1.2.1 Topography

The 12 Area, Site 13 is generally flat but with a moderate easterly slope on the eastern edge of the site. The 12 Area surface elevations range from 325 feet to 350 feet amsl. Topographically, three distinct areas have been investigated, which from highest to lowest are as follows: the knoll upon which existing Building 12052 is located, the terrace area formerly occupied by Building 1283, and the lower plateau occupied by an asphalt parking lot/staging area for military vehicles.

#### 4.1.2.2 Surface Water

There is no surface water present at the site. The nearest surface water body to 12 Area, Site 13 is the Site 21 oxidation pond; however, there is no direct surface pathway to the pond. During rainfall events, surface runoff follows topography and would most likely percolate directly into the soil at the east side of the site or heavy flow may reach the paved parking area east of the site. Surface runoff may eventually reach the same ephemeral tributary as Site 21, which flows toward Lake O'Neill.

#### 4.1.2.3 Geology

The 12 Area is situated in an upland plateau area elevated above the surrounding alluvial stream valleys. According to the available boring logs and cross sections from previous investigations (IT, 1996; OHM, 1997a) and current investigations, soil beneath the site generally consists of interbeds of sand, silty sand, sandy silt, silt, and clay. The sedimentary beds at this site are highly heterogeneous and laterally discontinuous (Parsons, 2004). There appears to be three distinct low permeability zones at 12 Area, Site 13:

- The first shallow zone occurs directly beneath ground surface at former Building 1283, but it is very limited laterally - this unit does not extend laterally away from the former building location;
- The second shallow zone, consisting of several layers of silt and clays, occurs between 7 and 25 feet bgs both east and north of the former Building 1283 terrace area; and
- The deep zone, consisting of silt and clay, occurs approximately 60 to 70 feet bgs and appears to extend both west and east of the site.

The subsurface deposits encountered at this site are described as dense to very dense sands; clay and silts are stiff to hard. Based on the review of boring logs drilled as part of previous and current investigations, it appears that relatively loosely consolidated fill, colluvium or slope wash overlies the dense to hard native material or bedrock. This loosely consolidated material is reported at maximum depths of approximately 15 feet bgs.

#### 4.1.2.4 Hydrogeology

Groundwater wells intercept both shallow and deep groundwater zones at 12 Area, Site 13. The groundwater flow direction in the shallow aquifer is consistently toward the east and mimics the topography, where the flow direction in the deep zone is consistently to the west, similar to the prevailing southwestern dip of the underlying sedimentary bedrock (La Jolla Group) The results of the previous (IT, 1996; OHM 1997b) and current investigations suggest that the shallow aquifer is discontinuous or perched across the site and that shallow groundwater may not behave uniformly or consistently. The site is located within the Upper Ysidora Hydrologic Subarea (2.13) of the Ysidora Hydrologic Area (2.10) of the Santa Margarita Hydrologic Unit (2.00) (RWQCB, 1994).

Groundwater within the perched groundwater zone appears to be contained primarily within discontinuous layers of sand, silty sand, and clayey sand The perched groundwater zone appears to be absent east of Site 13 in the lower parking area/staging area, as indicated by field observations while drilling wells S13-MW17 and S13-MW21. The deeper groundwater zone appears more uniformly and consistently in the sandy

layers directly above the deep, low permeably layer described above Individual saturated units within both the perched and deep water bearing zones are thin (generally 5 feet or less) and separated by thin layers described as dry or moist. Based on these observations, the thickness of the perched aquifer in 12 Area, Site 13 ranges from approximately 5 to 15 feet; the average thickness of this zone is roughly 10 feet (Parsons, 1999b; OHM, 1997a). The average thickness of the deeper aquifer ranges from 7 feet (S13-MW13) to approximately 15 feet (S13-MW12) and the average thickness is roughly 10 feet; however, because the deep wells only partially penetrate the deeper aquifer, this thickness should be considered a minimum.

The perched groundwater elevations are typically between 30 and 40 feet higher than the deep groundwater elevations, indicating that the perched ground is significantly isolated from the deeper zone. Due to the topographic relief between the well locations drilled at 12 Area, Site 13, there was a wide variation in the depth to groundwater within the perched aquifer, which varied from 18.46 to 38.46 feet bgs (groundwater elevations 314.32 to 325.47 feet amsl) during the two monitoring events (December 2001 and March 2003). Depth to groundwater within the deep aquifer was 28.85 to 82.53 feet bgs (groundwater elevations 279.53 to 293.00 feet amsl). Water level measurements in December 2001 and March 2003 indicate that groundwater elevations have fluctuated very little within individual wells. Typically water levels have fallen between 1 to 2 feet in any of the shallow wells measured between the two monitoring events, but typically have fallen less than 0.25 foot in the deep wells (Parsons, 2004). These recent shallow well fluctuations correlate to a seasonal fluctuation of 1 to 2 feet in water data between 1995 and 1997 (OHM, 1997a).

Groundwater flow in the perched aquifer is towards the east with a component to the east-northeast, with an average gradient of approximately 0.035 ft/ft across the entire site, including the shallow well drilled on the knoll to the west of 12 Area, Site 13. The shallow groundwater flow pattern roughly mimics the topographic contours in the area. However, the perched gradient across the eastern portion of the site (east of former Building 1283) is 0.1 ft/ft, which is significantly steeper than the topography. There was no perched groundwater encountered in wells drilled east of this area of steep gradients. The steep gradient and then the absence of the perched conditions farther to the east may suggest that perched groundwater is merging or infiltrating into the deep zone east of the site.

Deep groundwater at 12 Area, Site 13 generally flows west at a gradient of approximately 0.030 ft/ft. In the central portion of the site, the groundwater gradient is slightly steeper at approximately 0.035 ft/ft. The deep groundwater flow direction is opposite of the surface slope but in a similar direction to the dip of the underlying bedrock (La Jolla Group), which generally dip at shallow angles to the southwest.

The groundwater present below the 12 Area would not be considered a potential source of drinking water based on an analysis of site conditions relative to SWRCB Resolution 88-63. The resolution states that, except under specifically defined conditions, all surface and ground waters of the state are to be protected as existing or potential sources of municipal and domestic water supply. Two of the exceptions are groundwater TDS concentrations exceeding 3,000 mg/L and/or sustainable yields less than 200 gallons per day (gpd) for a single well (RWQCB, 1994)

The average TDS value based on geochemical results from all the 18 shallow wells sampled in January 2002 and March 2003 is approximately 6,172 mg/L with a minimum and maximum of 2,040 and 10,800 mg/L, respectively. The average TDS value based

on geochemical data from 12 deep wells sampled in January 2002 and March 2003 is approximately 9,688 mg/L, with a minimum and maximum of 4,550 and 12,000 mg/L, respectively. Based on these factors the groundwater at the Area 12 is not considered a potential source of drinking water as defined in State Resolution No. 88-63.

#### 4.1.2.5 Ecology

Most of 12 Area, Site 13 is undeveloped except for one paved road. The former buildings were demolished in 1992 and their remaining footprint was left as open soil. The site is vegetated with low-lying grasses and several trees on the eastern portion of the site. No special-status species are known or expected to inhabit the site

### 4.1.3 Nature and Extent of Contamination

The 12 Area, Site 13 is located at the former site of Building 1283. Former Building 1283 was a mess hall and former Building 1280 was a Quonset hut used for food storage. These buildings were demolished in November 1992, which is the same year Building 12052 was built. UST 13, which was associated with Building 1283 and removed prior to 1994, was a 1,500-gallon concrete tank used to store diesel fuel for heating.

The available data indicate that VOCs, primarily BTEX and TCE, are present in shallow groundwater at concentrations up to 11 µg/L. Figures 6-8 to 6-13 in Appendix B3 summarize detectable contaminant concentrations in site groundwater samples. Most of the contamination is centered on S13-MW1, which was installed at the former UST location. In March 2003, the maximum concentrations of benzene and TCE in S13MW-1 are 11and 10 µg/L, respectively. Benzene is also present in deep groundwater, with the highest concentration detected at S13-MW12 at 3.8 µg/L in March 2003. TCE was detected in December 2001 in deep groundwater at very low concentrations, with the highest concentration detected in S13-MW17 at 0.5 µg/L.

### 4.1.4 Contaminant Fate and Transport

Contaminant fate and transport is discussed in detail in the OU 5 RI (Parsons, 2004). This section provides a brief summary of the conditions specific to 12 Area, Site 13.

A significant factor controlling the transport of VOCs in shallow groundwater is the perched nature of the aquifer. Perched groundwater was not encountered in the area of deep well S13-MW17 drilled approximately 300 feet downgradient of well S13-MW1. Steeper groundwater gradients in this area coupled with the absence of perched conditions suggest that perched groundwater is discontinuous and merges or infiltrates into the deep aquifer east of the site. Low BTEX and TCE concentrations have been detected in well S13-MW17, which is an upgradient deep well.

BTEX concentrations in shallow groundwater have had some fluctuation but have remained relatively unchanged over time. Like most of the OU 5 sites, BTEX levels were abnormally high in the 2001-2002 site-wide sampling event, but were detected at levels more consistent with historical results in 2003. Petroleum compounds appear to be at steady state. Aerobic conditions in the groundwater outside the source zone appear to be allowing the low BTEX concentrations in these areas to biodegrade.

TCE concentrations also appear to be stable. An evaluation of the biodegradation potential for VOCs (BTEX and CAH compounds) in groundwater is presented in the OU 5 RI (Parsons, 2004). The geochemical data indicate limited evidence of reducing conditions in the perched groundwater in the source area around well S13-MW1 (e.g.,

low DO, low ORP, high TOC, high iron, some methane). However, the remainder of the shallow plume appears aerobic, and does not contain daughter-products indicative of reductive dechlorination in spite of the high TOC concentrations present. The TCE plume appears stable through natural attenuation factors other than biodegradation (e.g., dilution/dispersion).

Conditions in the deeper zone appear to be aerobic. TCE concentrations are low and are likely attenuating by dilution/dispersion processes even though anaerobic reductive dechlorination is not likely occurring. Since the deeper zone is even more aerobic than the shallow zone, any petroleum compounds impacting the deep aquifer are rapidly degrading.

As calculated using BIOSCREEN, the total mass of BTEX in the dissolved plume is estimated at 0.3 kg. Over 99 percent of the BTEX mass leaving the source area is removed within 300 feet of the source, approximately 80 percent by biodegradation. As discussed previously, aerobic conditions in the shallow groundwater outside the source zone and in the deep aquifer are driving the degradation of BTEX compounds in these areas.

The total mass of TCE in the dissolved plume is estimated at 0.4 kg. About 35 percent of the dissolved TCE mass leaving the source area is removed before the perched-deep groundwater merging point, none of it by biotransformation. A maximum TCE mass flux of 3.7 mg/day would reach this point at the peak TCE concentration. As discussed previously, the low TCE concentrations entering the deep aquifer will likely attenuate by dilution/dispersion even if reductive dechlorination does not occur.

### 4.1.5 Human Health Risk Assessment

This section provides a brief summary of the Human Health Risk Assessment (HHRA) discussed in detail in the OU 5 RI (Parsons, 2004). The RME risk to a hypothetical adult domestic groundwater user, based on default exposure assumptions and USEPA toxicity factors, was estimated to be $3 \times 10^{-3}$, with 1,2-dibromomethane (ethylene dibromide; $3 \times 10^{-3}$), benzene ($1 \times 10^{-4}$), and TCE ($8 \times 10^{-5}$) the primary contributors. The maximum route-specific adult hazard index was estimated to be 3, with TCE (HQ=2) the primary contributor. The maximum child hazard index was 7, with TCE (HQ=4) and benzene (HQ=3) the primary contributors.

For a hypothetical on-site commercial/industrial indoor receptor, the estimated incremental RME risk from the vapor intrusion pathway (shallow groundwater to indoor air) is approximately $6 \times 10^{-7}$ using USEPA toxicity factors. The primary contributor to risk was benzene ($4 \times 10^{-7}$) and TCE ($1 \times 10^{-7}$). The corresponding risk based on California toxicity factors was $2 \times 10^{-6}$, with benzene ($2 \times 10^{-6}$) and TCE ($2 \times 10^{-7}$) the primary contributors. The vapor intrusion evaluation was based on a number of conservative assumptions (i.e., the maximum concentration of all detected groundwater COPCs occurred in the same location, groundwater COPC levels remain constant for the entire exposure duration, and the future building is directly over the hypothetical point of maximum). Based on the conservative nature of the evaluation, further evaluation of vapor intrusion into indoor air is not recommended.

### 4.1.6 Ecological Risk Assessment

This section provides a brief summary of the Ecological Risk Assessment (ERA) discussed in detail in the OU 5 RI (Parsons, 2004). Only a Tier-1 screening risk assessment (SRA) was conducted for 12 Area, Site 13.

12 Area, Site 13 is a highly disturbed, graded location overlying groundwater contamination; the site surface is covered with some invasive weedy vegetation. This location generally lacks native vegetation, and any vegetation present consists predominantly of introduced species. Based on its location in the midst of mission-active areas, this location also lacks connectivity with other areas of habitat.

A fundamental component of the ERA process is the identification of complete exposure pathways. There must be a co-occurrence in space and time of an organism and a contaminant source; lacking this co-occurrence, there is no exposure of the organism to the contaminant, and the organism cannot be at-risk from that contaminant. For this developed site, with only subsurface contamination, there are currently no complete exposure pathways for ecological organisms.

Given the land-use designations, land-use plans, and lack of complete exposure pathways, 12 Area, Site 13 does not constitute suitable foraging habitat for ecological resources and there is no contact between potential receptors and contaminated groundwater. Lacking complete exposure pathways, this area does not need to be considered further in the ERA process.

### 4.1.7 RI Conclusions

Based on the data collected to date and the analyses documented in this report, the following RI conclusions were reached regarding 12 Area, Site 13:

- Site groundwater contains contaminants, primarily BTEX and TCE, at concentrations up to 11 µg/L (higher concentrations of benzene were reported in 2001 data, but these data are not consistent with prior and subsequent data and are considered anomalous).
- No COPCs were detected in the new upgradient perched-zone monitoring well west of the site, so an off-site upgradient source to the west is considered unlikely
- No COPCs were detected in the new downgradient deep monitoring well west of the site, so off-site migration to the west is considered unlikely.
- Based on historical site data, there is no evidence of a significant residual source of soil contamination at the site. However, minor residual free product is present that will serve as a continued source of dissolved VOCs to the groundwater.
- Based on further evaluation of hydrogeologic conditions at the site, a significant factor controlling the transport of VOCs to the east in shallow groundwater is the perched nature of the aquifer. Perched groundwater was not encountered in the area of deep wells S13-MW17 or S13-MW21. Steeper groundwater gradients coupled with the absence of perched conditions suggest that perched groundwater is discontinuous and merges or infiltrates into the deep aquifer east of the site. Low BTEX and TCE concentrations have been detected in well S13-MW17, which is an upgradient deep well.
- Based on fate-and-transport modeling, BTEX compounds in groundwater have reached a steady-state condition with concentrations above MCLs reaching a maximum distance of 270 feet. TCE is estimated to reach a maximum concentration of 7 µg/L in 20 years and will not migrate farther than approximately 300 feet from the site. The extent of downgradient migration is

limited by hydrogeologic conditions (i.e., the extent of the perched water-bearing zone).

- The groundwater present under 12 Area, Site 13 would not be considered a potential source of drinking water based on the sustainable yield and TDS criteria in SWRCB Resolution 88-63.
- The RME risk to a hypothetical adult domestic groundwater user, based on default exposure assumptions and USEPA toxicity factors, was estimated to be $3 \times 10^{-3}$. The maximum route-specific adult hazard index was estimated to be 3 and the maximum child hazard index was 7. Domestic use of the groundwater is extremely unlikely
- For a hypothetical on-site commercial/industrial indoor receptor, the estimated incremental RME risk from the vapor intrusion pathway (shallow groundwater to indoor air) is approximately $6 \times 10^{-7}$ using USEPA toxicity factors and the corresponding risk based on California toxicity factors was $2 \times 10^{-6}$. Based on the conservative nature of the evaluation, further evaluation of vapor intrusion into indoor air is not recommended.
- Based on the site-specific tiered ecological risk assessment for 12 Area, Site 13, the existing land-use designations, land-use plans, and a lack of complete exposure pathways to ecological receptors, the site does not need to be considered further in the ecological risk assessment process

## 4.2 Development of Remedial Action Objectives

As discussed in Section 1.4, per the framework of CERCLA, NCP, and SARA, the RI/FS and subsequent remedial activities conducted at 12 Area, Site 13 must comply with federal and state ARARs. The ARARs/TBC that potentially apply to 12 Area, Site 13 are discussed in detail in Appendix A. USEPA guidance (USEPA, 1988) requires that RAOs be developed during the initial phase of the FS and be used as the framework for developing the remedial alternatives. The remainder of Section 5 addresses the groundwater contamination at 12 Area, Site 13 that might require remediation as indicated during the RI.

### 4.2.1 Chemicals of Concern

Groundwater is the only significantly impacted medium at 12 Area, Site 13. As discussed in Section 4.1.2.4, VOCs, primarily BTEX and TCE, are present in shallow groundwater at concentrations up to 11 µg/L. Most of the contamination is centered on S13-MW1, which was installed at the former UST location. BTEX compounds have also been detected in deep groundwater at very low concentrations, with the highest concentration detected at S13-MW12 (benzene at 3.8 µg/L) in 2003

### 4.2.2 Exposure Routes/Receptors of Concern

The HHRA conducted for groundwater under the OU 5 RI (Parsons, 2004) used hypothetical adult domestic groundwater user, hypothetical child domestic groundwater user, on-Base adult domestic groundwater user, and on-Base child domestic groundwater user exposure scenarios to assess the risks to human receptors from contaminated groundwater. The risk assessment concluded that hypothetical domestic groundwater users could be exposed to contaminants via ingestion of VOCs.

The site is over one mile outside the Santa Margarita River basin and is over two miles east of the nearest water supply wells in 26 Area. The nearest in-service production well (10S/04W-07H02) is located over two miles downgradient to the west of the site, near Site 1111. The site is located approximately one mile southeast of Lake O'Neill, which is within the upper subbasin of the Santa Margarita River basin.

In addition, as discussed in Section 4.1.5, further evaluation of volatilization of VOCs from groundwater and vapor intrusion into the indoor air of buildings is not recommended.

### 4.2.3 Proposed Remedial Action Objectives and Remediation Goals

The following RAOs were developed for 12 Area, Site 13 groundwater contamination to address the protection of human health and the environment:

- Minimize inhalation/dermal contact/ingestion of contaminated groundwater containing VOCs at concentrations posing a risk to human health.
- Protect the beneficial uses and water-quality objectives of the lower Santa Margarita River basin.

Remedial goals were developed to meet these RAOs. As described in Section 4.1 and in the OU 5 RI Report (Parsons, 2004), the site is situated on a mesa, with the groundwater underlying the site having relatively high TDS concentrations. Based on overall topography of the site vicinity, groundwater would ultimately flow toward the Santa Margarita River, if a complete hydraulic connection exists between the site and the river.

VOCs entering the deep groundwater zone could conceivably but not likely migrate to Lake O'Neill, in the Santa Margarita River basin, approximately one mile downgradient of the site. Lake O'Neill is the point of entry to the Santa Margarita River basin. Assuming there is an existing groundwater pathway, the time for groundwater to travel from 12 Area, Site 13 to Lake O'Neill is conservatively estimated to be about 38 years (i.e., 157 ft/year).

Since 12 Area, Site 13 groundwater is not classified for beneficial use under federal or state standards, drinking water standards do not apply for this site. Rather, groundwater RGs for this site are designed to protect the beneficial-use waters of the Santa Margarita River basin downgradient of the site. The RGs for this site are defined as the maximum calculated concentration of COCs in groundwater downgradient of the site that would result in concentrations below drinking water standards at the entry point to the Santa Margarita River basin. Specifically, the groundwater model described in Appendix C2 calculates that a sustained concentration of 50 µg/L of TCE in downgradient groundwater monitoring well S13-MW19 would result in a corresponding concentrations at Lake O'Neill of 0.5 µg/L (i.e., background) and 5 µg/L (i.e., MCL), in approximately 41 and 50 years, respectively. As discussed in Section 1.5.2, background is defined as 0.5 µg/L in accordance with detection limits for purposes of reporting for VOCs promulgated under CCR Title 22, Division 4, Chapter 15, Article 5.5. Similar modeling conducted for BTEX compounds indicates that sustained concentrations upwards of 500 µg/L of benzene in site groundwater would breakdown to below detection limits long before they reach Lake O'Neill.

If contaminants in site groundwater continue to exhibit minimal downgradient migration, there will be no significant impact on beneficial-use groundwater, including the drinking water resources in the Santa Margarita River basin. Therefore the RGs are designed to

provide ample early warning of off-site migration at levels of concern to downgradient receptors In the case of 12 Area, Site 13, groundwater contaminant concentrations are significantly below the above-calculated values. Therefore, the potential threat to beneficial use groundwater at the Base is considered negligible.

The DON recognizes that the key substantive requirements of CCR Title 22, § 66264.94 (and the identical requirements of CCR Title 23, § 2550.4 and Section III.G of SWRCB Res. 92-49) require cleanup to background levels of constituents unless such restoration proves to be technologically or economically infeasible and an alternative cleanup level of constituents will not pose a substantial present or potential hazard to human health or the environment. At 12 Area, Site 13, considerable expense would be incurred to implement an active remediation system to achieve non-detectable concentrations (or MCLs) at the site. Because site groundwater is not useable as a drinking water source, it is considered economically infeasible to incur considerable expense to achieve no measurable benefit in terms of reduction in risk to human health or the environment. Various alternatives are evaluated in this FS to monitor the attenuation or migration of groundwater contamination in the source area.

## 4.3 Identification of General Response Actions

General Response Actions (GRAs) represent general classes of technologies that have common characteristics in the way they address the risk posed by contaminated groundwater (i.e., the RAOs). Following the USEPA guidelines (USEPA, 1988), these GRAs are considered for 12 Area, Site 13:

- No Action: No further remedial action for the environmental media.
- Institutional Control: Use restrictions and/or groundwater monitoring but no active remediation of the contaminated media; may include the analysis and evaluation of attenuation of contaminants via naturally occurring physical and biological processes.
- Containment: Primarily physical measures to restrict contaminant migration or waste movement
- Groundwater Extraction: Removal of contaminated material from the contaminated media.
- Treatment (in situ and ex situ): Physical, chemical, and biological measures that reduce toxicity, mobility, or volume of a contaminant or waste by altering the physical or chemical properties of the contaminants and/or media.
- Disposal/Discharge: Placement of treated or untreated material in a temporary or permanent, preengineered, controlled environment that will restrict contaminant migration and, thus, eliminate exposure routes.

## 4.4 Identification and Screening of Technology Types and Process Options

The objective of this section is to identify remedial technologies and process options for application for groundwater remediation at 12 Area, Site 13. This objective is accomplished using a variety of information including previous investigations, remedial actions at other sites, references developed by USEPA for application at NPL sites, USEPA computerized technology databases (ATTIC, Version 1.0, VISITT, Version 2.0, and CLU-IN), and standard engineering references

For each GRA discussed above, several remedial technologies exist that are applicable to the type of groundwater contamination at 12 Area, Site 13. The goal of the screening process is to evaluate a large number of these technologies to identify those that are technically feasible to implement under the site-specific conditions. In this step, both process options and entire technology types can be eliminated based on technical effectiveness and/or implementability considerations. Information on site characteristics and contaminant types and concentrations was used to eliminate technology types and process options that are neither applicable nor effectively implementable at the site.

The remedial technologies identified and evaluated in the previous feasibility studies performed for MCB Camp Pendleton IR sites served as the starting point for the list of technology options evaluated in this FS report. These evaluations were revised as appropriate to reflect current site conditions and technology updates. In addition, any relevant new technologies were added to the evaluation. A summary of the technologies evaluated in this FS is presented below:

- Institutional Controls
  - Use Restrictions
  - Wellhead Treatment
  - Groundwater Monitoring
  - Monitored Natural Attenuation
  - Alternate Water Supply
- Containment
  - Vertical Barriers
  - Hydraulic Barriers
  - Subsurface Drains
- Groundwater Extraction
  - Extraction Wells
  - Well Points
  - Dual Phase Extraction
  - Product Recovery
- Groundwater Discharge/Disposal
  - Surface Discharge
  - Treatment Plants/POTWs
  - Subsurface Discharge (Injection Wells)
- In Situ Physical Treatment
  - Air Sparging
  - In-Well Air Stripping
  - Hot Water/Steam Stripping
- In Situ Chemical Treatment
  - Chemical Oxidation
  - Permeable Reactive Barrier
- In Situ Chemical Treatment (con.)
  - Zero-Valent Iron Treatment in Source Area
- In Situ Biological Treatment
  - Enhanced Bioremediation
  - Phytoremediation
- Ex Situ Physical Treatment
  - Air Stripping
  - Liquid-Phase Carbon Adsorption
  - Membrane Separation
  - Flow Equalization
  - Sedimentation
  - Filtration
  - Liquid-Liquid Extraction
- Ex Situ Chemical Treatment
  - Ion Exchange
  - Chemical Precipitation
  - Oxidation - Reduction
  - Chemical Dechlorination
  - Coagulation/Flocculation
  - Coprecipitation
  - UV Oxidation
- Ex Situ Biological Treatment
  - Fixed-Film Bioreactor
  - Suspended Growth Bioreactor

Figure 4-3 lists the GRAs for 12 Area, Site 13 groundwater contamination, identifies the remedial technologies and process types for each response action, and presents a summary of the screening results for each technology and process. A brief description

of the technologies and process options under each GRA is provided in the following sections, along with the rationale for keeping or eliminating each technology

### 4.4.1 No Action

The no action response was retained for consideration during the development and analysis of alternatives as required by the NCP (40 CFR 300.430[e][6]). The no action response does not provide additional remediation, monitoring, or security at the sites to reduce potential risk to human health or the environment.

### 4.4.2 Institutional Controls

Institutional controls are actions taken to reduce or eliminate risks to public health and the environment by controlling exposure pathways rather than removing the contaminants or reducing their mobility, toxicity, or volume. Institutional controls may consist of physical restrictions, administrative restrictions, and/or monitoring of contaminants in groundwater. The institutional controls considered for 12 Area, Site 13 include groundwater use restrictions, wellhead treatment, groundwater monitoring, MNA, and an alternate water supply.

#### 4.4.2.1 Use Restrictions

Physical restrictions may include the use of signs and/or security measures to limit or prevent future use of groundwater at the site. Administrative restrictions include legal or Base-directed restrictions on construction activities and prohibitions on drilling of water wells and/or use of groundwater within the contaminated area. As discussed in Section 4.2.2, the site is not currently near a drinking water supply system. Restricting groundwater use in the contaminated plume is a viable option and was retained for further evaluation.

#### 4.4.2.2 Wellhead Treatment

This option involves treatment of groundwater at supply wells impacted by site contamination. The site is over one mile outside the Santa Margarita River basin and is over two miles east of the nearest water supply wells in 26 Area. Therefore, this option was not retained for evaluation.

#### 4.4.2.3 Groundwater Monitoring

Groundwater monitoring includes periodic sampling and analysis of groundwater from monitoring wells (either existing or new) strategically located to monitor plume conditions and the performance and progress of groundwater contaminant remediation. Groundwater monitoring plans are designed and tailored to address site-specific RAOs. The resulting data can be used to demonstrate trends in contaminant concentrations, to monitor contaminant migration and compliance with regulatory requirements, to track the performance and effectiveness of the selected remedy, or to determine when remedial goals have been met. Long-term monitoring of groundwater is an integral component of any remedial action alternative for groundwater and is conducted throughout the entire duration of the remediation process.

Groundwater monitoring can be implemented alone, in conjunction with institutional controls, or as a component of other treatment or containment alternatives. This process option is retained for further consideration.

#### 4.4.2.4 Monitored Natural Attenuation

Monitored natural attenuation (MNA) is a management strategy that relies on the evaluation and application of natural subsurface processes such as biodegradation, dispersion, dilution, adsorption, volatilization, and abiotic (chemical) degradation of groundwater contaminants (USEPA, 1998). MNA relies on these processes to achieve site-specific RAOs within a time frame that is reasonable compared to that offered by other more active methods (USEPA, 1999). Long-term groundwater monitoring is the major component of MNA. Monitoring of other media (e.g., soil gas, pond surface water/sediments) may be necessary to determine possible impacts to potential receptors and contaminant migration. Effective application of MNA involves a properly designed monitoring network and clearly defined performance criteria based on site-specific RAOs. MNA objectives are met through routine evaluations of institutional controls and measurements of contaminant, geochemical, and hydrologic parameters.

The mechanisms for natural attenuation of groundwater contaminants include non-destructive processes (advection, dispersion, dilution from recharge, sorption, and volatilization) that act to reduce contaminant concentrations via dilution or transfer to another medium, and destructive processes (biodegradation and abiotic degradation) that reduce contaminant mass. Of these processes, biodegradation is the mechanism that most commonly occurs to transform subsurface contaminants into innocuous by-products. During natural biodegradation, indigenous microorganisms reduce the total mass of contaminants in the subsurface without engineered enhancements. Patterns and rates of natural attenuation can vary markedly from site to site depending on governing physical and chemical processes.

Site-specific natural attenuation processes at 12 Area, Site 13 pertain to both BTEX and TCE concentrations in groundwater. A significant amount of analytical data has been collected since 1986.

The recent geochemical data indicate limited evidence of reducing conditions in the shallow aquifer in the source area around well S13-MW1 (e.g., low DO, low ORP, high TOC, high iron, some methane). TCE concentrations have remained relatively stable over time, although intermediate degradation products of reductive dechlorination (*cis*-1,2-DCE, vinyl chloride) are generally not evident, possibly due to the low initial concentrations of TCE and the competing electron acceptors present in the groundwater.

Predominant aerobic conditions outside the source zone and in the deep groundwater are driving the rapid degradation of BTEX compounds in these areas. A BIOSCREEN evaluation indicates that the BTEX plume is at steady state with an estimated length of 270 feet. Over 99 percent of the BTEX mass in the plume is removed within 300 feet of the source area, approximately 82 percent by biodegradation.

Biodegradation is actively occurring for BTEX compounds. While a thin layer of free-phase petroleum may continue to contribute BTEX constituents to groundwater within the source zone, the aerobic conditions in the groundwater outside the source zone are allowing the low BTEX concentrations in these areas to rapidly degrade. Conditions in the deeper groundwater zone also appear to be aerobic. A BIOSCREEN evaluation indicates that the BTEX plume is at steady state with an estimated distance of 270 feet downgradient of the source at the leading edge of the plume; however, aerobic conditions in the shallow and deep aquifer are promoting the rapid degradation of BTEX compounds in these areas.

There is no evidence of the presence of intermediate degradation products of reductive dechlorination (*cis*-1,2-DCE, vinyl chloride), suggesting that measurable biodegradation of TCE is not taking place.

Current TCE concentrations are very low, and therefore will attenuate by dilution/dispersion even if reductive dechlorination does not occur. The BIOCHLOR simulation indicates a peak TCE concentration of 7 µg/L in approximately 20 years when the plume reaches steady state.

MNA can be implemented alone, in conjunction with institutional controls, or as a component of other treatment or containment alternatives. MNA was previously recommended as the remediation strategy for this site in the 1997 Corrective Action Plan (CAP) (see Section 6.1.3 of the RI Report, Parsons 2004a). This process option is retained for further consideration.

#### 4.4.2.5 Alternate Water Supply

This option involves providing the users of the affected groundwater with an alternate supply of water. This may be accomplished by connecting the affected users to a city water supply, or by installing new water supply wells in nonimpacted areas of the aquifer. The site is over one mile outside the Santa Margarita River basin and is over two miles east of the nearest water supply wells in 26 Area. Therefore, this option was not retained for evaluation.

### 4.4.3 Containment

Containment measures are often used to prevent or significantly reduce the migration of groundwater contaminants out of the established plume boundary or into water supply systems. Containment involves the placement of physical barriers to stop or slow the movement of contaminated groundwater. Different types and constructions of control/containment systems are available for various environments and applications. A combination of containment barriers may be used to provide for adequate isolation and control of the groundwater plume. The containment technologies screened for groundwater include vertical barriers, hydraulic barriers, and subsurface drains.

#### 4.4.3.1 Vertical Barriers

Vertical barriers are structures such as a slurry wall, grout curtain, sheet piling cutoff wall, or vibrating beam wall that are capable of limiting downgradient contaminant migration. Because of the low concentrations of VOCs in groundwater and the depth of the aquifer's lower confining layer (approximately 60 feet), vertical barriers are not considered to be practical for 12 Area, Site 13. Therefore, this technology was not retained for further evaluation.

#### 4.4.3.2 Hydraulic Barriers

Groundwater pumping can be used effectively as a hydraulic barrier by lowering the groundwater levels (either piezometric levels or the water table) at the leading edge of the plume, to prevent downgradient migration of contaminants. Groundwater pumping can be used solely as a hydraulic barrier (without treatment), but is most often accompanied by some form of treatment of the extracted groundwater prior to discharge.

A key component of hydraulic barriers is a groundwater monitoring well network and sampling program designed to monitor the effectiveness of the containment system. In some situations, early warning monitoring wells located at designated sentry wells

between drinking water supply wells and the contaminant plume can be used to trigger pumping. Based on the site conditions, the use of hydraulic barriers is technically feasible and implementable. However, the current and historical data indicate that there is no downgradient migration of chlorinated VOC groundwater contamination from 12 Area, Site 13. Therefore, this technology was not retained for future evaluation.

#### 4.4.3.3 Subsurface Drains

Groundwater interceptor trenches can be constructed to intercept upgradient groundwater and transport it to a central area for treatment or proper disposal. Due to low VOC concentrations at 12 Area, Site 13, however, this option was considered impractical for capturing the contaminated groundwater. Therefore, it was not retained for further evaluation.

### 4.4.4 Groundwater Extraction

Groundwater extraction techniques involve the active manipulation and management of groundwater to contain or remove a plume. The use of groundwater pumping for hydraulic containment is discussed in Section 4.4.3.2. Groundwater extraction technologies evaluated for 12 Area, Site 13 include extraction wells, well points, dual-phase extraction, and passive product recovery. The selection of the appropriate extraction technique depends upon the remedial objectives, depth of contamination, and the hydrologic and geologic characteristics of the aquifer.

#### 4.4.4.1 Extraction Wells

Extraction wells are installed within a groundwater plume to pump contaminated groundwater out to the ground surface for treatment or management. The appropriate location, depth, and well configuration is determined by the boundaries of the groundwater plume, the hydrogeologic characteristics of the aquifer, and the remedial objective of the pumping system. The extraction rate and location of the wells are optimized to minimize extraction of clean groundwater and reduce the time needed to remove the contaminated groundwater plume. Well design focuses on enhancing performance and increasing the lifetime of the wells and pumps. Contaminant mass removal occurs as contamination sorbed to soil gradually dissolves into groundwater and then the contaminated groundwater is extracted. The time needed to remove the contaminated groundwater plume is dependent on the permeability of the aquifer and on the rate that contaminants disassociate from soil. Information generated during the RI indicates that the low permeability of the aquifer at 12 Area, Site 13 would not be suitable for the application of this technology; therefore, it was not retained for further evaluation.

#### 4.4.4.2 Well Points

A well point system is a matrix of driven wells connected to a single suction pump. Well points work best when the water to be extracted is within 20 feet of ground surface to be within suction limits. Well point systems are effective for construction dewatering purposes and are best used for localized dewatering in shallow low permeability zones. The normal capacity for a well point system is less than 20 gpm. Although well points are potentially applicable for shallow groundwater tables as found at 12 Area, Site 13, groundwater pumping and treatment of such low concentrations has been found to entail long-term O&M costs, for which there would be no measurable risk reduction in this case. Therefore, it was eliminated from further consideration.

#### 4.4.4.3 Dual Phase Extraction

This technology uses a high vacuum system to remove various combinations of contaminated groundwater, separate-phase product, and vapor-phase contamination from the subsurface. For dissolved organic groundwater contamination, such as at 12 Area, Site 13, high vacuum liquid/vapor treatment systems are designed to remove contaminants from above and below the water table. The system lowers the water table around the well, exposing more of the formation and making contaminants in the newly exposed vadose zone accessible to vapor extraction, which can remove contaminants more efficiently than pump-and-treat. The extracted liquids and vapors are separated and treated aboveground. This technology is most effectively used for low-permeability or heterogeneous formations. Although this technology is potentially applicable for groundwater at 12 Area, Site 13, the low organic concentrations significantly limit the effectiveness of this technology. Therefore, it is not retained for further evaluation.

#### 4.4.4.4 Passive Product Recovery

A passive skimmer is used to collect product (LNAPL floating on the groundwater surface) as it passes through a hydrophobic element without collecting well water. The unit is suspended in the well and passively recovers product as soon as product is available. No power source is required. The canister is periodically pulled from the well, emptied through the drain valve in the canister, and then replaced in the well. The small amount of free product remaining in the source area (S13-MW1) could be largely removed using a passive skimmer; therefore, this technology was retained for further consideration.

### 4.4.5 Groundwater Discharge/Disposal

After contaminated groundwater is brought to the ground surface, it must be discharged with or without treatment. Although no groundwater extraction options were retained (Section 4.4.4), possible disposal options are evaluated for Site 13 in this section, including surface discharge, treatment plant, and injection wells. A discussion of these disposal options is provided in the event that groundwater extraction is considered part of a viable strategy, or if significant quantities of water are removed as part of future field-scale testing. The feasibility of these options depends, in part, on whether the extracted groundwater is pretreated prior to discharge. This section evaluates the feasibility of discharge options with and without treatment, but does not discuss treatment options. Ex situ treatment technologies are discussed in Section 4.4.7.

If passive product recovery were chosen as part of site remedy, the very small volume of recovered product would be containerized and disposed of in accordance with applicable regulatory guidelines. Such product, if recovered from the subsurface, would not be a sufficient quantity to evaluate possible treatment options.

#### 4.4.5.1 Surface Discharge

This process option involves discharging to a designated surface water body on- or off-Base with or without treatment. Although a discharge permit may not be needed for on-Base surface discharges of untreated groundwater, substantive requirements would need to be met to ensure the protection of surface waters. Contaminant concentrations in 12 Area, Site 13 groundwater exceed discharge criteria and, therefore, on-Base surface discharge of untreated groundwater is not feasible. The use of a reliable treatment method such as activated carbon could provide the necessary protection for

discharge to a surface drainage. However, significant regulatory compliance issues and stringent water quality standards complicate this option and limit its feasibility.

The only off-Base surface water body near MCB Camp Pendleton suitable for surface discharge is the Pacific Ocean, located several miles away from the site. Certain standards (ARARs) must be met before groundwater could be discharged. In addition to the relatively far distance to the ocean, this option is impractical because the water must be treated prior to discharge. Therefore, because of distance, ARARs, and that no extraction options were retained, off-Base surface discharge is not retained for further evaluation.

#### 4.4.5.2 Discharge to Treatment Plant or Publicly Owned Treatment Works

Discharge of treated groundwater to a sanitation sewer and then pumping it to the on-Base sewage treatment plant is considered to be technically feasible because of the relatively close proximity of the plant to the groundwater contamination at 12 Area, Site 13. The capabilities of the on-Base wastewater treatment facility, located in the 22 Area, are limited to iron and manganese treatment. Chlorinated solvents in 12 Area, Site 13 groundwater cannot be effectively removed. Using the sewage treatment plant to receive the treated groundwater would eliminate significant regulatory restrictions (ARARs). However, the additional influent into the sewage treatment plant could place unacceptable loads on the plant capacity and may require significant capital upgrades to the plant. Adding above ground tanks to allow for temporary storage of the groundwater and then discharging to the Base plant at night (during low flow conditions) may reduce overall capital upgrades to the plant (i.e., flow equalization techniques). While this option for discharge of treated groundwater is considered technically feasible, no extraction options were retained and therefore disposal of extracted groundwater is unnecessary and is not retained for further evaluation.

Discharging extracted groundwater to a POTW located off-Base is also not an option because the three POTW facilities in Oceanside close to MCB Camp Pendleton are limited to municipal sewage treatment and cannot effectively treat the chlorinated organics in 12 Area, Site 13 groundwater. Therefore, because of these treatment limitations and that no extraction options were retained, the option to discharge untreated groundwater to an on-Base treatment plant or off-Base POTW is not retained for further evaluation.

#### 4.4.5.3 Subsurface Discharge

Injection wells may be installed to introduce water from the ground surface into the aquifer, under controlled conditions, usually to alter the movement of the groundwater plume. Injection wells can be used to return groundwater to the subsurface. Injection wells may also be used in conjunction with extraction wells to recirculate water while natural attenuation or other in situ process reduces levels of contaminants. Based on the low permeability of the aquifer and the low level of VOCs in groundwater at 12 Area, Site 13, the use of injection wells does not appear to be technically feasible for returning groundwater to the aquifer at this site. Therefore, because of the low permeability of the aquifer, the low level of VOCs in groundwater, and that no extraction options were retained, injection wells were not retained for further evaluation.

### 4.4.6 In Situ Treatment

The main advantage of in situ treatment is that it allows groundwater to be treated without being brought to the surface and results in significant cost savings. In situ

treatment, however, generally requires more time, and there is less certainty about the uniformity of treatment because of the variability in aquifer characteristics and because the efficiency of the process is more difficult to verify.

In situ treatment includes both engineered and enhanced natural processes capable of destroying or immobilizing dissolved contamination in place. In some instances, compounds may break down into more toxic by-products, or regulated products may be introduced into the aquifer that may be mobilized in groundwater if no control techniques are used. To address this issue, in situ processes are typically performed above a low-permeability soil layer and with groundwater monitoring wells downgradient of the remediation area. In situ treatment is generally less expensive than ex situ treatment because it entails no cost for pumping, treating, and discharging of extracted groundwater. In situ treatment technologies evaluated for groundwater at 12 Area, Site 13 fall into three broad groups: physical, chemical, and biological.

#### 4.4.6.1 In Situ Physical Treatment

Physical treatment uses the physical properties of the contaminants or the contaminated medium to destroy or separate the contamination. Technologies in this group evaluated for 12 Area, Site 13 include air sparging, dual phase extraction, in-well air stripping, hot water/steam flushing, and passive/reactive treatment walls.

##### 4.4.6.1.1 Air Sparging/Soil Vapor Extraction

Air sparging is an in situ technology in which air is injected through a contaminated aquifer. Injected air traverses buoyantly in channels through the soil column, creating an underground stripper that removes contaminants by volatilization. Air may be injected through vertical or horizontal wells. This injected air helps to flush (bubble) the contaminants up into the unsaturated zone where an SVE system is usually implemented in conjunction to remove the generated vapor phase contamination. Air sparging can also enhance aerobic biodegradation of the less chlorinated ethenes by increasing the oxygen content of the saturated zone. Air sparging has a medium to long duration that generally lasts up to a few years. The technology is well suited to treat VOC contamination in highly permeable, coarse-grained, relatively homogeneous aquifer material in which a uniform distribution of air bubbles is possible.

Air sparging has been demonstrated at numerous sites, but is not potentially applicable to 12 Area, Site 13 groundwater because of the low concentrations of VOCs in groundwater and the low permeability aquifer conditions. Therefore, neither horizontal nor vertical air sparging are retained for further evaluation.

##### 4.4.6.1.2 In-Well Air Stripping

In-well stripping works on the same principle as air stripping. Air is injected into a double screened well, using a diffuser to create a stream of fine bubbles. The rising bubbles create an airlift pump that lifts the water in the well and forces it out the upper screen. Contaminated groundwater is simultaneously drawn into the lower screen, which creates a hydraulic circulation pattern that allows continuous cycling of groundwater. Once in the well, some of the VOCs in the contaminated groundwater are transferred from the dissolved phase to the vapor phase by the air bubbles. The contaminated air rises in the well to the water surface where vapors are drawn off and treated by an SVE system. The SVE system also collects vapors from the vadose zone surrounding the well. As groundwater circulates through the treatment system in situ, contaminant concentrations are gradually reduced through multiple cycles to achieve the desired cleanup level. In-

well air stripping is a technology that is potentially applicable for the organic contamination in groundwater at 12 Area, Site 13 and is retained for further evaluation.

4.4.6.2 In Situ Chemical Treatment

Chemical treatment uses the chemical properties of the contaminants or contaminated media to destroy the contaminants by converting them to innocuous compounds commonly found in nature. Chemical oxidation, permeable reactive barriers, and chemical reduction using zero-valent iron in the source zone were the in situ chemical treatment process options evaluated for 12 Area, Site 13. These innovative technologies are being widely tested to evaluate their effectiveness for in situ remediation of organic contamination.

4.4.6.2.1 Chemical Oxidation

In situ chemical oxidation involves the injection of chemical oxidants into the groundwater aquifer to react with and destroy the contaminants. The typical oxidants used in this process are Fenton's reagent (hydrogen peroxide [$H_2O_2$] combined with soluble iron), potassium permanganate ($KMnO_4$), and ozone ($O_3$). The appropriateness of this technology at a site depends on matching the oxidant and delivery system to the site contaminants, geochemistry, and hydrogeology (Siegrist et al., 2001).

In situ chemical oxidation treatment is not applicable at 12 Area, Site 13 because VOC concentrations are generally too low for significant reductions to occur through treatment. Therefore, in situ chemical oxidation is not retained for further evaluation for 12 Area, Site 13 groundwater.

4.4.6.2.2 Permeable Reactive Barrier

This technology is based on vertical barriers that are placed in the path of a contaminant plume as discussed in Section 4.4.3.1. A passive treatment wall is permeable to uncontaminated water, allowing it to continue its natural course through the flow system while removing or degrading the contaminants as contaminated water moves through the wall. A permeable reactive barrier (PRB) wall consists of a subsurface groundwater treatment zone that is filled with reactive media. The most typical configuration and type of PRB is a downgradient trench that is filled with ZVI for reductive dechlorination of contaminants, including TCE. The PRB wall is installed below the ground surface and across the flow path of a contaminant plume, allowing the contaminants to be treated while the groundwater plume passively moves through the wall. The PRB technology is not applicable for 12 Area, Site 13 due to the depth to bedrock (approximately 60 feet bgs) and because VOC concentrations are generally too low for significant reductions to occur through treatment. Therefore, this technology option is not retained for further evaluation.

4.4.6.2.3 Zero-Valent Iron Treatment in Source Area

ZVI may also be emplaced within the source area or core of a plume for in-plume treatment. However, ZVI is not applicable at this site because VOC concentrations are generally too low for significant reductions to occur through treatment. Therefore, this technology option has not been retained for further evaluation.

4.4.6.3 In Situ Biological Treatment

In situ bioremediation techniques are destruction techniques directed toward stimulating microorganisms in the subsurface to grow and use the contaminants as a food and energy source by creating a favorable environment for the microorganisms. Generally

this means providing some combination of oxygen, nutrients, and moisture, and controlling the temperature and pH. Contaminants are destroyed and little to no residual treatment is required.

The in situ bioremediation techniques evaluated for the 12 Area, Site 13 VOC plume include enhanced bioremediation and phytoremediation.

4.4.6.3.1 Enhanced Bioremediation

Bioremediation describes the destruction of groundwater contaminants by biologically mediated processes. Enhanced bioremediation utilizes addition of substrate, reagents, or microorganisms into the subsurface to accelerate the natural biodegradation processes. Bioremediation can occur under aerobic (oxygenated) or anaerobic (lacking oxygen) conditions; however, anaerobic conditions favor the biological degradation of TCE and other highly chlorinated CAHs through anaerobic reductive dechlorination. Typically aerobic conditions favor the biological degradation of BTEX compounds. The addition of an organic substrate to an aquifer to promote anaerobic conditions for CAH degradation or air or oxygen-bearing compounds to promote aerobic conditions for BTEX degradation has been demonstrated to stimulate microbial growth and development at many sites (AFCEE et al., 2004; Battelle, 1996).

Aerobic biodegradation of BTEX compounds appears to be already ongoing in the subsurface. However, due to the current lack of evidence of anaerobic reductive dechlorination occurring at the site in spite of the high TOC concentrations present, the addition of carbon substrate would likely do little to promote biodegradation of the CAHs present. Therefore, there is no added benefit to applying an enhanced bioremediation approach; hence, enhanced bioremediation is not retained for further evaluation for 12 Area, Site 13 groundwater.

4.4.6.3.2 Phytoremediation

Phytoremediation is an emerging technology that uses plants and their associated rhizospheric (root zone) microorganisms to remove, degrade, or contain chemical contaminants located in soil, sediment, or groundwater. Newer methods of phytoremediation have been able to use trees for the dual purpose of direct treatment of contaminants in the aquifer and as pumping mechanisms to control groundwater flow. Research has indicated that plants can be used to treat most classes of compounds, including chlorinated solvents. Plant species are selected for phytoremediation based on their potential to evapotranspirate groundwater, the degradative enzymes they produce, their growth rate and yield, the depth of their root zone, and their ability to bioaccumulate contaminants. Phytoremediation can only work at sites well-suited for plant growth where the contaminants present are within the plant root zone and not too deep, at concentrations that are not toxic to the plants. Based on the depth to contaminated groundwater (approximately 20 to 25 feet bgs) and the low concentrations of VOCs, this technology is not applicable for addressing the groundwater contamination at 12 Area, Site 13. Therefore, it is not retained for further consideration.

### 4.4.7 Ex Situ Treatment

The main advantage of ex situ treatment is that it generally requires shorter time periods, and there is more certainty about the uniformity of treatment because of the ability to monitor and continuously mix the groundwater. Ex situ treatment, however, requires pumping of groundwater above the ground surface, leading to increased costs and engineering for treatment equipment, permitting, and material handling. Although no

groundwater extraction options were retained (Section 4.4.4), possible ex situ treatment options are evaluated for 12 Area, Site 13 in this section. A discussion of these treatment options is provided in the event that groundwater extraction is considered part of a viable strategy in the future, or if significant quantities of water are removed as part of future field-scale testing in the future. Ex situ treatment technologies that were evaluated for groundwater at 12 Area, Site 13 fall into three broad groups: physical, chemical, and biological.

#### 4.4.7.1 Physical Treatment

Physical treatment uses the physical properties of the contaminants or the contaminated medium to separate, or contain, the contamination. While no extraction options were retained and therefore treatment of extracted groundwater would not be necessary, possible physical treatment technologies were evaluated for 12 Area, Site 13 including air stripping, adsorption, membrane separation, flow equalization, sedimentation, filtration, and liquid/liquid extraction.

##### 4.4.7.1.1 Air Stripping

Air stripping is a full-scale technology in which VOCs are partitioned from extracted groundwater by greatly increasing the surface area of the contaminated groundwater exposed to air. Air stripping involves the mass transfer of volatile contaminants from water to air. For groundwater remediation, this process is typically conducted in a packed tower or aeration tank. The typical packed tower air stripper includes a spray nozzle at the top of the tower to distribute contaminated water over the packing in the column, a fan to force air countercurrent to the water flow, and a sump at the bottom of the tower to collect decontaminated groundwater. Aeration tanks strip volatile compounds by bubbling air into a tank through which contaminated water flows. A forced air blower and a distribution manifold are designed to ensure air-water contact without the need for any packing materials. Aeration tanks may include a series of shallow trays. An air emission control and treatment system (e.g., activated carbon, catalytic oxidizers, or thermal oxidizers) is used for both towers and tanks to capture and destroy the contaminated air. Several vendors offer these technologies as either skid-mounted units or permanent installations.

Air stripping is most effective for VOCs with Henry's Law constants greater than 0.01 atm-$m^3$/mol such as TCE, DCE, and other chlorinated VOCs. The eventual duration of cleanup using an air stripping system may be tens of years and depends on the capture of the entire plume from groundwater. While air stripping is potentially applicable for the low concentrations of VOCs in the groundwater at 12 Area, Site 13, no extraction options were retained and therefore treatment of extracted groundwater in unnecessary and air stripping is not retained for further evaluation.

##### 4.4.7.1.2 Liquid-Phase Carbon Adsorption

Liquid-phase carbon adsorption is a full-scale technology that involves pumping groundwater through a series of canister or columns containing activated carbon to which dissolved organic contaminants adsorb. Periodic replacement or regeneration of saturated carbon is required when contaminant concentrations in the effluent exceeds a certain level. The carbon can be regenerated in place, removed and regenerated at an off-site facility, or removed, and disposed of. Pretreatment for removal of suspended solids from streams to be treated is an important design consideration to maximize the life of the carbon units and minimize backwashing downtime

Carbon adsorption systems can be deployed rapidly, and contaminant removal efficiencies are high. Carbon adsorption is particularly effective for polishing water discharges from other remedial technologies to attain regulatory compliance. Limited effectiveness may be achieved for halogenated hydrocarbons. While carbon adsorption is potentially applicable to treat the low concentrations of VOCs in the groundwater at 12 Area, Site 13, no extraction options were retained and therefore treatment of extracted groundwater is unnecessary and carbon absorption is not retained for further evaluation.

#### 4.4.7.1.3 Membrane Separation

In membrane separation technologies, semipermeable membranes separate certain contaminants from a wastewater stream. These technologies do not destroy or alter the chemical or physical state of a contaminant; instead, they generate a clean stream and a reject stream in which contaminants that could not pass through the membrane are concentrated. The reject stream may need further treatment before disposal. Multiple units may be used in series to provide further concentration of the waste stream. In contrast to media filters, flow is typically tangential to the membrane surface and, as a result, a continuous flushing is induced to minimize plugging of the membrane. Major process designs for these technologies include ultrafiltration, dialysis, and reverse osmosis. Ultrafiltration is ineffective for removing VOCs and inorganics from groundwater because the molecules of these compounds are too small to be retained by the membranes. Dialysis and reverse osmosis would not be appropriate for removing the low concentrations of chlorinated VOCs in the groundwater at 12 Area, Site 13. Therefore, membrane separation was not retained for further consideration.

#### 4.4.7.1.4 Flow Equalization

Equalization is a starting point for many treatment processes to provide for a waste stream of uniform strength, consistency, and flow. The equalization process may allow interaction between various groundwater sources, thereby producing a degree of equalization without additional chemical treatment. This option is useful after extraction of groundwater and prior to treatment. This option does not directly address the VOC contamination in groundwater, but it is potentially applicable as a support technology. However, no extraction options were retained and therefore this technology is not retained for further evaluation.

#### 4.4.7.1.5 Sedimentation

Sedimentation is a process that relies on gravity to remove suspended solids in an aqueous stream. It can be performed as either a batch or continuous process in lined impoundments, conventional settling basins, clarifiers, and high-rate gravity settlers. It is commonly applied to large volume aqueous wastes with high-suspended solids loading. Sedimentation may be required as a pretreatment step for chemical processes, but it is not commonly applied to small-scale groundwater remediation applications. This option does not directly address the VOC contamination in groundwater, but it is potentially applicable as a support technology. However, due to the large space requirements generally required for sedimentation compared to alternative separation alternatives (i.e., filtration), sedimentation is not retained for further evaluation.

#### 4.4.7.1.6 Filtration

This technology involves removing suspended solids from solution by forcing the fluid through a porous medium. Common types of filters include sand, bag, membrane, or bed filters with various media. As the water-solids mixture passes through the porous media, the solid particles become trapped. Filtration may be needed to reduce the

suspended solids content in groundwater to optimize the efficiency of the treatment system. This option does not directly address the VOC contamination in groundwater, but it is potentially applicable as a support technology. However, no extraction options were retained and therefore this technology is not retained for further evaluation.

#### 4.4.7.1.7 Liquid/Liquid Extraction

Liquid/liquid extraction is the separation of constituents from a liquid solution by contact with another immiscible liquid in which the constituents are more soluble. Liquid/liquid extraction systems range from simple-stage mixer settlers to elaborate multistage extraction columns, run in a cross current, or more commonly, in a countercurrent mode. This technology is effective in treating water with high organic contamination levels. Considering the low VOC concentrations in the 12 Area, Site 13 groundwater, this technology is not retained for further consideration.

### 4.4.7.2 Chemical Treatment

Chemical treatment uses the chemical properties of the contaminants or the contaminated medium to destroy (i.e., chemically convert) the contamination. While no extraction options were retained and therefore treatment of extracted groundwater would not be necessary, possible chemical treatment technologies were considered for 12 Area, Site 13 groundwater including ion exchange, chemical precipitation, oxidation-reduction, chemical dechlorination, coagulation/flocculation, coprecipitation, and UV/chemical oxidation.

#### 4.4.7.2.1 Ion Exchange

This treatment technology uses natural or synthetic inorganic microcrystalline structures, such as zeolites, and synthetic organic ion-exchange resins (Perry and Chilton, 1973) to exchange less desirable ions in the solution for the more desirable ions on the resin. The ion-exchange process is reversible, and the driving force for the exchange of ions is a function of the equilibrium governed by the relative insolubilities of the salts formed in the exchange process. Ion-exchange technology is not viable for VOCs; therefore, it is not retained for further evaluation.

#### 4.4.7.2.2 Chemical Precipitation

This technology turns a dissolved ionic contaminant into an insoluble phase, which can then be removed or recovered. Several methods can induce precipitation in a solution. Chemicals also may be added to cause a shift in equilibrium, resulting in precipitation or coalescence. Chemical precipitation is not viable for VOCs; therefore, it is not retained for further evaluation.

#### 4.4.7.2.3 Oxidation-Reduction

In chemical oxidation-reduction reactions, the oxidation state of the treated compound is raised or lowered by chemical addition. Considering that the organic contamination primarily includes relatively low concentrations of chlorinated VOCs in the 12 Area, Site 13 groundwater, this technology is not retained for further consideration.

#### 4.4.7.2.4 Chemical Dechlorination

Chemical dechlorination involves chemical reactions using catalysis, reduction, or oxidation to dehalogenate certain classes of chlorinated solvents. This technology is not retained for further consideration on the account of the low VOC concentrations.

#### 4.4.7.2.5 Coagulation/Flocculation

Coagulation/flocculation involves the controlled addition of chemical reagents (e.g., alum and polymers) to create a suspension of fine particles and transform the suspension of particles into flocculents of coagulated material of larger particles. The flocculents may be easily separated by gravity, thickening, skimming, filtration, or centrifugation. Coagulation/flocculation is not an effective treatment method for the VOCs found in the contaminated groundwater at 12 Area, Site 13. While this technology is not considered further as a primary treatment technology, it could be incorporated as a potential support action. However, due to the large space requirements generally required for coagulation/flocculation, this technology is not retained for further evaluation.

#### 4.4.7.2.6 Coprecipitation

Coprecipitation occurs when precipitation of an ionic compound is promoted by precipitation of a heavy metal in the wastewater. Coprecipitation is ineffective for removing VOCs from groundwater, and thus, is not retained for further consideration.

#### 4.4.7.2.7 Ultraviolet Oxidation

UV oxidation is a destruction process that oxidizes organic contaminants in groundwater by the addition of strong oxidizers and irradiation with UV light. Oxidation of target contaminants is caused by direct reaction with oxidizers, UV photolysis, and through the synergistic action of UV light, in combination with ozone ($O_3$) and/or hydrogen peroxide ($H_2O_2$). If complete mineralization is achieved, the final products of oxidation are carbon dioxide ($CO_2$), water, and salts. A wide variety of organic contaminants, including chlorinated solvents, are susceptible to destruction by UV oxidation. However, due to the low VOC concentrations measured at the site, this technology is not retained for further evaluation.

### 4.4.7.3 Biological Treatment

While no extraction options were retained and therefore treatment of extracted groundwater would not be necessary, ex situ biological treatment was still evaluated for 12 Area, Site 13. In ex situ biological treatment, contaminants in extracted groundwater are brought into contact with microorganisms in bioreactors. Bioreactors involve the use of a material to which the microorganisms adhere and grow. There are two major types of bioreactors: fixed-film and suspended growth. In fixed-film bioreactors, such as rotating biological contractors and trickling filters, microorganisms are established on an inert support matrix. In suspended growth bioreactors (e.g., activated sludge, fluidized beds, or sequencing batch reactors), contaminated groundwater is circulated in an aeration basin in which a microbial population aerobically degrades the organic matter.

The dilute nature of contaminated groundwater in general, and the very low concentrations of VOCs in 12 Area, Site 13 groundwater in particular, are unlikely to support an adequate microbial population density for this technology to be effective under the site conditions. Therefore, ex situ biological treatment was not retained for further evaluation.

## 4.5 Evaluation of Technology Process Options

The next step in developing and screening alternatives involves an evaluation of the technologies and process options remaining from the initial technology screening. Technologies and process options judged to be potentially viable in the previous section

for application to 12 Area, Site 13 groundwater are reviewed according to three criteria: effectiveness, implementability, and cost. These criteria are briefly discussed below.

- **Effectiveness.** The effectiveness evaluation focuses on the following elements:
  - Potential effectiveness of process options for handling the estimated areas or volumes of media and meeting the RGs identified in the RAOs
  - Potential impacts to human health and the environment during the construction and implementation phase
  - Reliability and proven effectiveness of the process with respect to the contaminants and conditions at the site
- **Implementability.** The initial technology screening eliminated technology types or process options that were clearly ineffective or unworkable at the site. This evaluation addresses both the technical and institutional feasibility of implementing each process including the following institutional aspects:
  - Ability to obtain necessary permits and rights-of-way for off-site actions
  - Availability of necessary equipment and skilled workers to implement the technology
  - Availability (including capacity) of treatment, storage, and disposal services
- **Cost.** Cost plays a limited role in the screening of technologies at this phase. Relative capital and O&M costs are considered rather than absolute costs. For this evaluation, the cost analysis is based on engineering judgment. Each technique is evaluated as to whether costs are low, moderate, or high relative to other process options in the same technology type. The greatest cost consequences in site remediation are usually associated with the degree to which different technology types are used. Using different process options within a technology type usually has a less significant effect on cost than the use of different technology types. A technology process option can be eliminated on the basis of costs only if other process options within the same technology type are comparably effective and implementable but have a much lower cost

Figure 4-4 lists all the technologies and process options that passed the initial screening in the previous section. Based on the above criteria, the process options were evaluated relative to other processes within the same technology type to select a representative process option to be included in a remedial alternative. At this stage of the FS, the major focus is on the effectiveness of each option; implementability and cost are of lesser importance. Each criterion is rated as low, moderate, or high relative to the technologies within the same process option. The results of the evaluation are discussed in the following sections and are summarized in Figure 4-4.

### 4.5.1 No Action

The evaluation of the no action option for groundwater is summarized below:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Although contaminants would remain in the groundwater, concentrations would decrease over time due to natural attenuation. The effectiveness of the no action option is rated low because groundwater use would be unrestricted and monitoring would not be conducted to evaluate the process of natural attenuation. | Low |
| Implementability | No equipment, skilled workers, or permits are required for the no-action option. | High |
| Cost | No cost is associated with no action | High |

The no action option is retained for incorporation into remedial action alternatives, as required by the NCP, and will be used as a baseline for comparison of other options

### 4.5.2 Institutional Controls

Use restrictions, groundwater monitoring, and MNA were retained as process options for this GRA and are evaluated below.

#### 4.5.2.1 Use Restriction

This option involves restricting the use of groundwater from within the contaminated groundwater plume near 12 Area, Site 13 with land-use restrictions. The evaluation of this option is summarized below:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Although contaminants would remain in the groundwater, concentrations would decrease over time due to natural attenuation. This option would protect human health by limiting access to groundwater. | Low to Moderate |
| Implementability | The Base would implement restrictions for on-Base property use; specifically, that groundwater in the area impacted by the contaminants from 12 Area, Site 13 would not be used for drinking water. | High |
| Cost | Costs associated with this option include minimal administrative costs. | High |

Based on the high ratings for implementability and cost, use restriction is retained for incorporation into the remedial action alternatives.

#### 4.5.2.2 Groundwater Monitoring

This option involves the use of the existing monitoring well network and/or the installation of new wells to monitor the groundwater plume. The evaluation of this option is summarized as follows:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Groundwater monitoring is an effective, reliable, and proven technology that is an integral component of any remedial action. The potential impact on human health and the environment from implementation of groundwater monitoring is negligible. This option is effective for monitoring plume size and concentrations and for early warning of contaminant migration | Moderate |
| Implementability | A monitoring network already exists in the general vicinity of 12 Area, Site 13. If additional wells are needed, they can be installed quickly; equipment and services are readily available. This option involves selection of monitoring locations based on the predicted plume movement. | High |
| Cost | Costs include well construction, well maintenance, sampling and analysis, data evaluation, and reporting | Moderate to High |

Based on the high rating in implementability, and the moderate effectiveness and cost of this option, groundwater monitoring is retained for use in conjunction with other remedial options.

#### 4.5.2.3 Monitored Natural Attenuation

This option involves using the existing monitoring well network and/or installing new wells to monitor the continued effectiveness of natural attenuation and to track the movement of the groundwater plume. The evaluation of this option is summarized as follows:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | MNA is an effective and proven technology that can be implemented alone or as a strategic component of the overall remedy. This option involves strategic selection of monitoring well locations based on the predicted groundwater flow paths, plume attenuation rates, and location of potential receptors. The potential impact on human health and the environment from implementation of MNA is negligible. If implemented alone, MNA is a long-term remedy; therefore, its effectiveness is rated as moderate. | Moderate |
| Implementability | MNA is data driven. Effective implementation requires a properly designed groundwater monitoring network and sampling and analysis plan, and clearly defined performance criteria based on site-specific RAOs. The existing groundwater monitoring well network at 12 Area, Site 13 can be easily adapted to satisfy MNA requirements. Needed additional wells can be installed quickly; equipment and services are readily available. | High |
| Cost | Costs include well construction, well maintenance, groundwater sampling and analysis for measurement of contaminant, geochemical, and hydrologic parameters, routine evaluation of institutional controls, data evaluation, and reporting. | Moderate |

Biodegradation of BTEX compounds is likely occurring in 12 Area, Site 13, but anaerobic reductive dechlorination throughout the plume has not been demonstrated for TCE. However, other natural attenuation processes appear to be controlling the TCE plume. Therefore, based on the high rating in implementability, and the moderate effectiveness and cost of this option, MNA is retained for further evaluation for use as a stand-alone or in conjunction with other remedial options.

### 4.5.3 Containment

No containment process options were retained from the initial screening.

### 4.5.4 Groundwater Extraction

The process option retained from the initial screening for removal is the use of passive product recovery. This option involves installing a passive recovery device in an existing well to recover product remaining in the source area.

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Passive product recovery is an effective, reliable, and proven technology for removing product (gas and diesel) from groundwater. The potential impact on human health and the environment from implementation is negligible | High |
| Implementability | Passive product recovery is a well-demonstrated technology. Equipment is readily available and easy to install. | High |
| Cost | Capital costs include the passive product recovery device. O&M costs associated with system include emptying the device, minor maintenance, and disposal of product recovered. | Moderate |

Due to its high ratings for effectiveness and implementability, and moderate cost, this option is retained for incorporation into the remedial action alternatives.

### 4.5.5 Groundwater Discharge / Disposal

Because hydraulic containment and groundwater extraction were not retained for further consideration as remedial alternatives, there is no need for groundwater discharge or disposal options to be evaluated further.

### 4.5.6 In Situ Treatment

In-well air stripping was the only in situ groundwater treatment processes retained after the initial screening of technologies phase. The evaluation of this process option is summarized below:

| Criterion | Evaluation | Rating |
|---|---|---|
| Effectiveness | Although this technology may be applicable for site contaminants, previous testing has shown limited effectiveness using this technology. | Low |
| Implementability | Materials and equipment are readily available; however, this innovative technology has limited full-scale implementation | Moderate |
| Cost | Major cost components include equipment operation, and well installation and maintenance. This option includes vapor extraction, treatment, and discharge costs. | Moderate |

Based on the low effectiveness and moderate implementability and cost ratings, this option is not retained for incorporation into the remedial action alternatives.

### 4.5.7 Ex Situ Treatment

No ex situ treatment options were retained from the initial screening.

### 4.5.8 Summary of Process Option Selection

The selection of process options for remediation of groundwater at 12 Area, Site 13 are summarized below:

- The no action response is retained as required by the NCP
- Use restrictions, long-term groundwater monitoring, and MNA are selected as institutional controls.
- Passive product recovery is retained as a process options.

The selected process options were retained for further consideration in developing remedial alternatives for 12 Area, Site 13 groundwater. Different combinations of these process options are assembled to form sitewide remedial alternatives. Not all of the selected process options are included in an alternative. Some of the process options that are not being carried forward to the next phase at this time could be reconsidered during the design phase, assuming that the evaluation criteria are satisfied to a similar degree. The process options actually used to implement the design may not be selected until the remedial design phase.

## 4.6 Development and Detailed Analysis of Alternatives

Guidance for the development of remedial alternatives for 12 Area, Site 13 groundwater was obtained from the following sources:

- 40 CFR 300 (NCP)
- Section 121 of SARA
- Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, 1988)
- Navy/Marine Corps Installation Restoration Manual (US Navy, 1992)

As required by the NCP and recommended by USEPA (1988) guidance, acceptable engineering practices that relate to site-specific conditions were considered during development of the remedial action alternatives. For 12 Area, Site 13, the media of

concern addressed by this FS is groundwater. The remedial alternatives for 12 Area, Site 13 groundwater were developed to address the remedial COCs and to satisfy the requirements of 40 CFR 00.430(e), which specifies that alternatives be developed to include no action, institutional controls, little or no treatment, and those that reduce the toxicity, mobility, or volume of contaminants.

Calculations and a BIOSCREEN/BIOCHLOR simulations were used to estimate mass and to predict contaminant plume trends under current conditions. Figures 6-8 to 6-13 in Appendix B3 illustrate the estimated spatial extent of VOC contamination at 12 Area, Site 13. The total mass of TCE in the dissolved plume is estimated at 0.4 kg. The BIOCHLOR evaluation indicates that TCE concentrations at the perched-deep groundwater merging point approximately 300 feet downgradient of the source area will reach a peak of 7 µg/L in about 20 years. The BIOSREEN evaluation indicates that the BTEX plume is at steady state with an estimated length of 280 feet. The total mass of BTEX in the dissolved plume is estimated at 0.3 kg.

As discussed in Section 4.2.3, drinking water standards do not apply for 12 Area, Site 13 groundwater. Rather, groundwater RGs for this site are designed to protect the beneficial-use waters of the Santa Margarita River basin from off-site migration. A BIOCHLOR evaluation of potential off-site migration indicates that an RG of 50 µg/L TCE measured in downgradient well S13-MW19 is protective of the Santa Margarita River groundwater basin. A similar BIOSCREEN evaluation for BTEX compounds indicates that sustained concentrations upwards of 500 µg/L of benzene in downgradient well S13-MW19 would breakdown to below detection limits levels long before they reach Lake O'Neill. Actual TCE and BTEX concentrations in 12 Area, Site 13 groundwater are much lower and already meet these RGs.

### 4.6.1 Overview of the Detailed Analysis and the Nine NCP Evaluation Criteria

An overview of the detailed analysis process and the nine NCP evaluation criteria is presented in Section 1.6.

### 4.6.2 Description of Remedial Action Alternatives

The following four alternatives were developed to address the remediation of contaminated groundwater at 12 Area, Site 13:

- Alternative 12A-1: No Action
- Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal
- Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2

#### 4.6.2.1 Alternative 12A-1: No Action

Under the no action alternative, no remedial actions of any kind would be undertaken. The NCP requires that a no action alternative be retained for detailed evaluation as a baseline against which the other alternatives are compared. Existing monitoring wells would be secured and locked to prevent illegal disposal or tampering. No remediation or sampling of the groundwater would be conducted. No cost is associated with this alternative.

Natural attenuation processes would continue to degrade contaminants; however, there would be no groundwater monitoring data collected to document and demonstrate that

the plume is not migrating. As noted previously, site groundwater is not considered beneficial use as defined in SWRCB Resolution 88-63.

#### 4.6.2.2 Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal

This alternative relies on effective implementation of administrative control measures. Institutional controls would ensure that the affected groundwater would not be used in the future, thereby maintaining the current lack of exposure to, and risks from, groundwater contaminants. Groundwater monitoring would ensure that groundwater contamination is not migrating to the Santa Margarita River basin. Product removal in the source area will reduce the contaminant source to the degree possible, thereby enhancing the ability of the aquifer to decrease contaminant concentrations over time.

Institutional controls would be implemented to ensure that the affected groundwater would not be extracted or used for any purpose in the future until appropriate regulatory standards have been met. These institutional controls would ensure that the RAOs are achieved while COCs are still present in the subsurface. Institutional controls include restrictions on future access to the groundwater in the immediate vicinity of the site. Land use restrictions would include enforcing long-term restrictions on deep basement excavations (greater than 15 feet bgs), and restrictions on the installation of additional water supply wells within the shallow and deep aquifers of 12 Area, Site 13. The intent of these restrictions would be to eliminate the pathway for potential receptor exposures to site-related contaminants until plume concentrations are reduced below action levels. Land-use controls to restrict access to contaminated groundwater would be implemented, and enforced by periodic on-site inspections and audits. An institutional control plan would also be prepared and implemented to document the adherence to controls. The institutional control plan would be subject to periodic (5-year) reviews to assess the effectiveness at meeting RAOs.

If institutional controls are selected to be all or part of the remedy for the OU 5 sites, such controls will be implemented by MCB Camp Pendleton as part of the site approval process. Site approval is required for all projects at the Base involving construction, acquisition, or modification. Once site approval is requested, MCB Camp Pendleton Environmental Security must be consulted for environmental approvals, including for NEPA determination if applicable. The form that is used to initiate the site approval process is called the "Preliminary Environmental Data Sheet." Currently Mark Bonsavage is the primary point of contact for projects potentially affecting IR sites. If Mark vacated the position, whoever assumed the roll of IRP Manager would review the site approvals.

The role of Environmental Security in the site approval process includes maintaining a GIS system for environmental constraints at the Base, including wetlands, sensitive species, and IR sites. If a planned activity requires environmental review or falls within an area specified on the Environmental Operations map, Environmental Security must review the proposed actions and make recommendations.

This alternative also involves implementing a long-term monitoring program to document that groundwater contamination is not migrating off-site to the Santa Margarita River basin. The initial monitoring network for this alternative is presented in Table 4-1 and Figure 4-5. As discussed in Section 4.6, RGs of 50 µg/L for TCE and 500 µg/L for BTEX measured in downgradient well S13-MW19 are protective of the Santa Margarita River basin and provide ample early warning of off-site migration at levels of concern to

downgradient receptors. Actual BTEX and TCE concentrations in groundwater at 12 Area, Site 13 are well below these RGs. If these RGs were exceeded in downgradient well S13-MW19 at some time in the future, then additional analysis and/or remedial measures would be implemented. Groundwater monitoring for contaminant off-site migration would continue until the RAOs have been met.

The monitoring network and sampling frequency would be continually reevaluated and revised as needed in response to plume changes and to determine if additional data would be needed to support the CERCLA 5-year review. Periodic site reviews (i.e., 5-year reviews) would be conducted using the long-term monitoring data to confirm changes in the extent and magnitude of contamination over time, assess dissolved contaminant plume dynamics, document the continued destruction of contaminant mass, confirm the effectiveness of institutional controls at eliminating exposure vectors, and reassess the potential for additional remedial actions to accelerate restoration of the site. For cost estimating purposes, 20 years of long-term monitoring was assumed. There is uncertainty in this estimate, but the estimate is considered reasonable given the relatively low contaminant concentrations.

This alternative would utilize a passive product recovery in the source area (S13-MW1). LNAPL recovery is required to remove the contaminant source to the degree possible, thereby enhancing the ability of the aquifer to decrease contaminant concentrations over time. Since the LNAPL layer appears to be confined to a single well, LNAPL recovery will only be implemented at well S13-MW1. Intermittent LNAPL recovery was previously performed at this well from 1996 to 2001, resulting in recovery of only approximately 10 gallons of product over 5 years (Appendix A5, RI Report). The passive product recovery would be implemented using a skimmer system as described in Section 4.4.4.4. It would likely be beneficial to allow the fairly small amount of free product (LNAPL) to remain at the site to help maintain a reducing environment that would facilitate TCE degradation. Therefore, product recovery should be conducted until approximately one inch of product remains until TCE has degraded, then removed completely.

If institutional controls, or land use controls, are chosen as the selected remedy for this site, a detailed description of the institutional controls or land use controls will need to be included in the ROD and Remedial Action Plan (RAP). The DON memo titled *Monitoring and Enforcement of Land Use Controls* (U.S. Navy, 2003) provides specific items to be included in the ROD and RAP, including listing the parties responsible for enforcing the land use controls, and the need for five-year reviews.

#### 4.6.2.3 Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2

In addition to the institutional controls, limited groundwater monitoring to ensure that there is no downgradient migration of contaminated groundwater, and passive product removal in the source area (Alternative 12A-2), this alternative involves implementing a long-term monitoring program to document the performance and effectiveness of natural attenuation processes (e.g., dispersion, degradation, sorption, and volatilization) to contain and degrade groundwater contaminants before they reach downgradient receptors. The logistics associated with the implementation of this alternative would be addressed in a Remedial Action/Monitored Natural Attenuation Work Plan for the site. Because actual contaminant concentrations in groundwater are already below the recommended RGs, the success of this alternative relies on the ability of natural attenuation processes to effectively contain and prevent any VOC migration.

The overall objectives of the performance monitoring for MNA at 12 Area, Site 13 include:

- Demonstrate that natural attenuation is occurring according to expectations.
- Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other) that may reduce the efficacy of natural attenuation processes.
- Identify any potentially toxic and/or mobile transformation by-products.
- Verify that the plume is not expanding.
- Verify there is no unacceptable impact to downgradient receptors.
- Demonstrate the efficacy of institutional controls to protect potential receptors.
- Verify attainment of remediation objectives.

MNA would include collection of site-specific monitoring data to demonstrate continued reduction in the total mass of contaminants in groundwater over time. The primary classes of parameters to be monitored include VOCs, geochemical indicators of transformation processes, and hydrogeologic parameters. MNA quantitative models such as NAS, BIOSCREEN, or BIOCHLOR will be used to help understand site processes, locate monitoring points, estimate attenuation rates, and evaluate the effects changing conditions on MNA effectiveness. This alternative assumes that no engineered groundwater remediation activities would be conducted. Rather, this alternative relies on natural attenuation mechanisms to control plume expansion and remove BTEX and TCE from groundwater. Long-term monitoring would be required to document contaminant removal from the groundwater system, and to verify that MNA is proceeding to acceptable endpoints. The plan would comply with USEPA guidance for performance monitoring of MNA remedies for VOCs in groundwater (USEPA, 2004a).

An initial network of 15 existing groundwater monitoring wells would be sampled to monitor for VOCs and geochemical parameters that act as indicators of biodegradation. Table 4-2 and Figure 4-6 present the proposed initial MNA monitoring network. The long-term monitoring network would consist of performance well and compliance (i.e., sentry) well monitoring (AFCEE, 2000; Weidemeier and Haas, 2002). The new data would provide the basis to refine the conceptual site model and to modify monitoring network locations, parameters, and frequencies in response to changes in site conditions.

Site MNA data would be used to evaluate plume behavior and judge the effectiveness of the MNA remedy, the adequacy of the monitoring program, and the adequacy of the conceptual site model for MNA. Based on these judgments, decisions would be made for subsequent phases of the site remediation, including:

- Continue MNA without change
- Modify the performance monitoring program
- Modify the institutional controls
- Implement a contingency or alternative remedy
- Terminate MNA

The long-term monitoring plan would include site-specific criteria to define the conditions that indicate the appropriateness of these decisions (e.g., increased or decreased monitoring parameters or frequency, new sampling points, contingency remedy, etc.), including action-triggering RGs enforceable at sentry wells. As discussed in Section 4.6, RGs of 50 µg/L for TCE and 500 µg/L for BTEX measured in downgradient well S13-MW19 are protective of the Santa Margarita River basin and provide ample early warning of off-site migration at levels of concern to downgradient receptors. Actual BTEX and TCE concentrations in groundwater at 12 Area, Site 13 are well below these RGs. If these RGs were exceeded in downgradient well S13-MW-19 at some time in the future, then additional analysis and/or remedial measures would be implemented.

Periodic site reviews (i.e., 5-year reviews) also could be conducted using the long-term monitoring data to confirm changes in the extent and magnitude of contamination over time, assess dissolved contaminant plume dynamics, document the continued destruction of contaminant mass, confirm the effectiveness of institutional controls at eliminating exposure vectors, and reassess the potential for additional remedial actions to accelerate restoration of the site.

Natural attenuation of petroleum hydrocarbons has been documented at 12 Area, Site 13 based on several years of data, and the existing monitoring network is adequate for implementation of this remedy. The long-term monitoring program would include designation of performance well and compliance (i.e., sentry) wells for monitoring (AFCEE, 2000; Weidemeier and Haas, 2002).

The existing network of 15 groundwater monitoring wells (nine shallow and six deep wells) would be sampled to monitor for VOCs and geochemical parameters that act as indicators of biodegradation. For cost estimating purposes, it is assumed that long–term groundwater monitoring would be conducted for a period of 20 years as follows: semiannually for the first 2 years, annually for years 3 through 5, every 3 years for years 6 through 10, and every 6 years thereafter.

Performance and compliance monitoring for MNA would continue until the RAOs have been met, followed by a period of verification monitoring. The sampling frequencies, monitoring locations, and parameters used during verification monitoring may differ from those used during performance monitoring, and would be determined based on site conditions. Once verification monitoring shows that the MNA remedy goals have been met, MNA would be terminated.

### 4.6.3 Detailed Analysis of Alternatives

The objective of the detailed analysis of alternatives is to present and interpret the relevant information necessary to select the most appropriate remedy for 12 Area, Site 13 groundwater. The detailed analysis consists of an assessment of the individual alternatives described in the previous section against the nine NCP criteria. The results of this analysis provide the basis for the selection of an appropriate remedy for the site, and demonstrate satisfaction of the CERCLA remedy selection requirements in the ROD.

The following sections present the detailed analysis of the four remedial alternatives developed for the 12 Area, Site 13.

#### 4.6.3.1 Overall Protection of Human Health and the Environment

An analysis of how well each alternative meets overall protection of human health and the environment is provided below.

Alternative 12A-1: No Action

The no action alternative includes no treatment and no control of exposure pathways. Under this alternative, short and long-term risks would be unacceptable if contaminated groundwater were used for domestic purposes. Therefore, this alternative does not provide adequate protection of human health if the groundwater in the plume area were to be used as drinking water in the future. At present, no risk exists to human receptors from the contaminated groundwater because the impacted groundwater is not used for domestic purposes.

Long-term risk may be reduced as the contaminant concentrations naturally attenuate over time. Even though it is highly unlikely that 12 Area, Site 13 groundwater would be used for domestic purposes, the RME risk to a hypothetical adult domestic groundwater user, based on default exposure assumptions and USEPA toxicity factors, was estimated to be $3 \times 10^{-3}$. The maximum route-specific adult hazard index was estimated to be 3 and the maximum child hazard index was 7. Groundwater fate-and-transport analysis indicates that VOC contaminants in groundwater would persist at concentrations above MCLs for over 100 years. However, the groundwater present under 12 Area, Site 13 would not be considered a potential source of drinking water based on the sustainable yield and TDS criteria in SWRCB Resolution 88-63.

Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal

The institutional controls alternative adequately protects human health and the environment by restricting future use of the impacted groundwater and effectively eliminating the exposure pathway. Groundwater monitoring will allow a periodic assessment of the groundwater quality, facilitate plume tracking, and permit a periodic evaluation of additional actions, if necessary. Passive product removal in the source area will reduce the time before contaminant concentrations in groundwater reach MCLs. Implementation of this alternative would not have any adverse environmental or health impacts

Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2

In addition to the benefits described in Alternative 12A-2, MNA will allow a periodic assessment of the groundwater quality, facilitate plume tracking, and permit a periodic evaluation of additional actions, if necessary. Implementation of this alternative would not have any adverse environmental or health impacts. Long-term risk would be reduced as the contaminant concentrations naturally attenuate over time.

#### 4.6.3.2 Compliance with ARARs

An analysis of how well each alternative complies with ARARs is provided below.

Alternative 12A-1: No Action

The no action alternative would not comply with ARARs. Drinking water standards are not ARARs because 12 Area, Site 13 does not have a potential drinking water source. Although contaminant concentrations detected in the groundwater exceed the established risk-based RG, these would eventually be attained in groundwater through natural attenuation processes. RGs are chemical-specific ARARs for 12 Area, Site 13 groundwater. No location-specific ARARs are identified for the no action alternative. Alternative 12A-1 would not meet RCRA requirements for closure with no post-closure care or RCRA groundwater monitoring requirements (Appendix A).

Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal

Alternative 12A-2 would comply with ARARs. Risk-based RGs levels would be attained in 12 Area, Site 13 groundwater through natural attenuation processes and contaminant mass removal in the source area using passive product recovery. Drinking water standards are met at the sentry wells. Alternative 12A-2 would also comply with RCRA hazardous waste and groundwater protection requirements. This alternative includes monitoring to evaluate the effectiveness of natural attenuation and complies with federal and state groundwater monitoring requirements (Appendix A). Upon reaching cleanup goals, Alternative 12A-2 would comply with RCRA closure with no post-closure care requirements for groundwater (Appendix A).

Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2

Alternative 12A-3 would comply with ARARs. Risk-based RGs, which are considered chemical-specific ARARs for this site, would be attained in 12 Area, Site 13 groundwater through natural attenuation processes and contaminant mass removal in the source area using passive product recovery. Drinking water standards are met at the sentry wells. Alternative 12A-3 would also comply with RCRA hazardous waste and groundwater protection requirements. Alternative 12A-3 includes monitoring to evaluate the effectiveness of MNA and product recovery actions, and complies with federal and state groundwater monitoring requirements (Appendix A). Upon reaching cleanup goals, Alternative 12A-3 would comply with RCRA closure with no post-closure care requirements for groundwater (Appendix A).

#### 4.6.3.3 Long-Term Effectiveness and Permanence

An analysis of the long-term effectiveness and permanence for each alternative is provided below.

Alternative 12A-1: No Action

This alternative would not provide any actions or controls to reduce the existing contaminant levels or risks to human health and the environment. Although fate-and-transport analysis indicates contaminant levels would eventually reach MCLs and background through natural attenuation process, no measures are provided to monitor its effectiveness or to control exposure during the duration of this alternative. As a result, the long-term effectiveness and permanence criterion is rated low for this alternative.

Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal

Alternative 12A-2 does provide actions to reduce risks to human health and the environment and to monitor groundwater to verify there is no migration off site. It provides restrictions of future groundwater use, which limits the potential for human exposure and risks. Removing the residual product would reduce the contaminant mass from the groundwater plume and would accelerate the time frame for attaining the remedial objectives. Therefore, this alternative would provide high long-term effectiveness and permanence.

Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2

In addition to the benefits described in Alternative 12A-2, Alternative 12A-3 does provide actions to reduce risks to human health and the environment and to monitor continued

reduction in contamination levels. Long-term monitoring proposed for this alternative further reduces the potential for exposure by periodically assessing the extent of contamination and the degree of plume reduction. This alternative monitors the reduction of contaminant levels to MCLs and background (nondetectable) levels via natural attenuation while effectively controlling and monitoring potential exposure throughout the duration. Therefore, this alternative would provide high long-term effectiveness and permanence.

#### 4.6.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

An analysis of the reduction of toxicity, mobility, or volume through treatment for each alternative is presented below.

Alternative 12A-1: No Action

This alternative would not include active treatment and would not provide for any reduction of toxicity, mobility, or volume through treatment of the contaminated groundwater. Therefore, this criterion is rated low for this alternative. However, passive remediation via natural attenuation is expected to reduce groundwater contaminant levels to proposed RGs.

Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal

The product recovery would reduce the contaminant mass and the volume of contaminated groundwater requiring remediation as treatment proceeds. Similarly, the aggregate toxicity of the contaminants in groundwater would be reduced as their concentrations are reduced over time. Therefore, the reduction of toxicity, mobility, and/or volume for Alternative 12A-2 is rated high.

Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2

As described for Alternative 12A-2, product recovery would reduce the contaminant mass and the volume of contaminated groundwater requiring remediation. Therefore, the reduction of toxicity, mobility, and/or volume for Alternative 12A-3 is rated high.

#### 4.6.3.5 Short-Term Effectiveness

An analysis of the short-term effectiveness for each alternative is provided below.

Alternative 12A-1: No Action

No remedial actions would be implemented under the no action alternative; therefore, this evaluation criterion is rated low.

Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal

Field activity associated with this alternative includes installation of a passive recovery device in addition to monitoring of groundwater wells. A site-specific sampling plan, as well as a site-specific health and safety plan, would be prepared and implemented. Field personnel participating in the sampling activity would wear PPE as specified in the health and safety plan. Short-term effectiveness is rated moderate for this alternative.

Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2

Field activity associated with this alternative includes installation of a passive recovery device in addition to monitoring of groundwater wells. A site-specific sampling plan, as

well as a site-specific health and safety plan, would be prepared and implemented. Field personnel participating in the sampling activity would wear PPE as specified in the health and safety plan. Short-term effectiveness is rated moderate for this alternative.

4.6.3.6 Implementability

An analysis of the implementability of each alternative is provided below.

Alternative 12A-1: No Action

This alternative is not rated because no action would be taken.

Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal

Implementability is ranked high for Alternative 12A-2. Limiting groundwater use is an administrative process that is readily implementable. The Base would have primary responsibility for implementing this alternative and has the authority and capability to establish appropriate safeguards and to monitor and enforce compliance. Existing staff within the Base Environmental Security Office would coordinate all on-Base construction activities to ensure appropriate environmental review. Institutional controls for IR sites are maintained on a central GIS that is readily accessible. Downgradient monitoring wells already exist at 12 Area, Site 13. If additional wells are needed, they can be installed quickly; equipment and services are readily available. This option involves selection of monitoring locations based on the predicted migration rate of the plume. Passive product recovery is a commonly used technology and readily implementable.

Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2

Implementability is ranked high for Alternative 12A-3. A monitoring network already exists at the site. If additional wells are needed, they can be installed quickly; equipment and services are readily available. This option involves selection of monitoring locations based on the predicted attenuation rate of the plume.

4.6.3.7 Cost

A summary of the costs is provided below.

Alternative 12A-1: No Action

No costs are associated with Alternative 12A-1.

Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal

For cost estimating purposes, it is assumed that monitoring will be conducted for 20 years to verify that plumes are not migrating off site. The total cost for Alternative 12A-2 is approximately $324,300. The capital costs include the preparation of an institutional control plan, a work plan, sampling and analysis plan, quality assurance project plan, health and safety plan, long-term monitoring plan, and product recovery system installation. The O&M cost includes labor, maintenance, material, shipping, analysis, waste disposal, data validation, and report preparation. A detailed breakdown of these costs is presented in Appendix F4.

Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2

For cost estimating purposes, it is assumed that monitoring will be conducted for 20 years. The total cost for Alternative 12A-3 is approximately $438,700. The capital costs

include the preparation of a work plan, sampling and analysis plan, quality assurance project plan, health and safety plan, and long-term monitoring plan. The O&M cost includes labor, maintenance, material, shipping, analysis, waste disposal, data validation, and report preparation. A detailed breakdown of these costs is presented in Appendix F4.

## 4.7 Comparative Analysis

This section provides a comparative evaluation of the alternatives for the 12 Area, Site 13 using the nine NCP criteria used in Section 4.6 and discusses the relative advantages and disadvantages of the alternatives. Table 4-3 presents a brief description of each alternative, and the comparative analysis is summarized below.

### 4.7.1 Overall Protection of Human Health and the Environment

Alternatives 12A-1, 12A-2, and 12A-3 would reduce risk to acceptable levels via natural attenuation. Alternative 12A-1 is not considered to be protective of human health and the environment because it would not implement any measures to limit potential exposure or monitor the effectiveness of the remedial action. Alternative 12A-2 is considered to be protective by continued enforcement of use restrictions and groundwater monitoring to verify there is no contaminant migration downgradient. Alternative 12A-3 is considered to be protective by continued enforcement of use restrictions and groundwater monitoring and is expected to demonstrate continued compliance with RGs. Alternatives 12A-2 and 12A-3 provide product removal to reduce contaminant concentrations.

### 4.7.2 Compliance with ARARs

Alternative 12A-1 would not comply with RCRA closure and postclosure requirements or RCRA groundwater monitoring requirements. Alternatives 12A-2 and 12A-3 would comply with all ARARs including chemical-specific, location-specific, and action-specific ARARs. Chemical-specific ARARs would be achieved for Alternatives 12A-2 and 12A-3 via natural attenuation processes and passive product recovery.

### 4.7.3 Long-Term Effectiveness and Permanence

Alternative 12A-1 would not provide any remedial actions or controls; therefore, long-term effectiveness and permanence are considered to be low for this alternative. The long-term effectiveness of Alternative 12A-2 would be dependent on continued enforcement of use restrictions and monitoring to ensure there is no contaminant migration off site. The long-term effectiveness of Alternative 12A-3 would be dependent on the effectiveness of natural attenuation processes acting on the groundwater contamination. Fate-and-transport analysis indicates that VOC contamination in groundwater would remain indefinitely. Alternatives 12A-2 and 12A-3 provide a higher degree of long-term effectiveness and permanence through product removal, and also provide some additional long-term effectiveness by accelerating remediation time frames.

### 4.7.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 12A-1 would not reduce toxicity, mobility, or volume through active treatment. However, this alternative achieves contaminant reduction via natural attenuation.

Alternatives 12A-2 and 12A-3 provide a higher degree of reduction in toxicity, mobility, and volume through product removal.

### 4.7.5 Short-Term Effectiveness

Alternative 12A-1 is not effective in the short term because no response actions would be taken. Alternatives 12A-2 and 12A-3 pose minimal risk to site workers during groundwater sampling and analysis, but could pose some potential for exposure to workers during passive skimmer installation.

### 4.7.6 Implementability

This criterion is not applicable to Alternative 12A-1 because no actions or controls would be implemented as part of this alternative. Alternatives 12A-2 and 12A-3 are readily implementable and rank high in implementability.

### 4.7.7 Cost

No cost is associated with Alternative 12A-1. Alternative 12A-2 would be less expensive than Alternative 12A-3, with an estimated cost of $324,300. Alternative 12A-3 is the most expensive remedial alternative, with a cost of approximately $438,700. A summary of the costs associated with the implementation of each of the three remedial alternatives proposed for the 12 Area, Site 13 groundwater is presented in Appendix F4.

### 4.7.8 Summary of Comparative Analysis

The results of the comparative analyses are summarized below.

| Criteria | Alternative | | |
|---|---|---|---|
| | 12A-1[a] | 12A-2[b] | 12A-3[c] |
| **Threshold Criteria** | | | |
| Overall Protection of Human Health and the Environment | No | Yes | Yes |
| Compliance with ARARs | No | Yes | Yes |
| **Balancing Criteria** | | | |
| Long-Term Effectiveness and Permanence | Low | High | High |
| Reduction of Toxicity, Mobility, or Volume by Treatment | Low | High | High |
| Short-Term Effectiveness | Low | Moderate | Moderate |
| Implementability | Not Rated | High | High |
| Cost ($ million) | 0 | $0.32 | $0.44 |
| Remedial Timeframe | N/A | 20[d] | 20[d] |

[a] No Action.
[b] Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal.
[c] Monitored Natural Attenuation with Alternative 12A-2.
[d] Assumed monitoring timeframe. RGs are currently met at the site, and the site conditions are anticipated to stay in compliance with RGs.

Alternative 12A-1 is not protective of human health; does not meet ARARs; provides little short- or long-term effectiveness and permanence; achieves no reduction in toxicity, mobility, or volume through active treatment; and has no associated cost.

Both Alternatives 12A-2 and 12A-3 would provide adequate protection of human health and the environment and comply with ARARs. Both alternatives provide short-term effectiveness and are readily implementable. The plume behavior over the last 10 years supports fate-and-transport predictions that detectable contaminant concentrations in groundwater are not migrating. Alternatives 12A-2 and 12A-3 would provide a high degree of long-term effectiveness and permanence by reaching MCLs sooner; the highest reduction in toxicity, mobility, or volume through treatment; and a decreased remediation time. Alternative 12A-2 would provide the monitoring necessary to track plume movement and ensure effectiveness, as well as the necessary restrictions to limit exposure to the site contaminants. In addition, Alternative 12A-3 includes monitoring to evaluate the effectiveness of MNA. Alternative 12A-2 is the least costly alternative that would be protective of human health and the environment and achieve ARARs.

**Table 4-1**
**12 Area, Site 13 - Alternative 12A-2 Institutional Controls, Long-Term Monitoring, and Product Removal**
**Initial Long-Term Monitoring Well Network**

| Target Monitoring Zones | Description | Initial Monitoring Locations | Performance Monitoring Objectives | Monitoring Parameters | Monitoring Frequency |
|---|---|---|---|---|---|
| **Baseline Sampling** | All existing 12 Area Site 13 wells | - Existing shallow wells S13-MW1, S13-MW6, S13-MW8, S13-MW9, S13-MW10, S13-MW11, S13-MW13, S13-MW16, S13-MW18<br>- Existing deep wells S13-MW12, S13-MW14, S13-MW15, S13-MW17, S13-MW19, S13-MW21. | - Establish a baseline to actualize site conditions and confirm that plume is stable and not migrating.<br>- Evaluate baseline sampling to determine list of selected wells, if any, for plume monitoring. | - VOCs | - Semi annually for first year only. |
| **Plume Monitoring** | Selected wells based on Site conditions | - Initially existing shallow wells S13-MW1, S13-MW8.<br>- Initially existing deep wells S13-MW15, S13-MW17.<br>- Dynamic list to be determined every year based on site conditions. | - Track plume behavior to evaluate site conditions.<br>- Modify monitoring well network to add or drop plume-tracking ells based on changing site conditions. | - VOCs | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5.<br>- Bi-annually thereafter. |
| **Sentry Wells** | Designated early warning points between plume boundaries and possible receptors. | - Existing deep well S13-MW19 | - Verify that VOC concentrations are below RGs.<br>- Detect unacceptable plume migration or impact to receptors which requires implementation of contingency actions. | - VOCs | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5.<br>- Bi-annually thereafter. |
| **Groundwater Hydrology** | All existing 12 Area, Site 13 wells | - Entire IC&LTM GW monitoring network (15 wells) | - Determine that there are no changes in groundwater flow rates and directions that would impact plume stability.<br>- Estimate hydraulic gradients. | - Groundwater elevations. | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5.<br>- Bi-annually thereafter. |
| **Summary** | | **- 15 Existing shallow wells** | | | |

**Table 4-2**
**12 Area, Site 13 - Alternative 12A-3 Monitored Natural Attenuation**
**Initial MNA Monitoring Well Network**

| Target Monitoring Zones | Description | Monitoring Locations | Performance Monitoring Objectives | Monitoring Parameters | Monitoring Frequency |
|---|---|---|---|---|---|
| **Baseline Sampling** | All existing 12 Area Site 13 wells | - Existing shallow wells S13-MW1, S13-MW6, S13-MW8, S13-MW9, S13-MW10, S13-MW11, S13-MW13, S13-MW16, S13-MW18<br>- Existing deep wells S13-MW12, S13-MW14, S13-MW15, S13-MW17, S13-MW19, S13-MW21. | - Establish a baseline to actualize site conditions and confirm that plume is stable and not migrating.<br>- Evaluate baseline sampling results to determine the need for any modifications to the initial MNA monitoring network. | - VOCs<br>- Geochemical parameters. | - Semi annually for first year only. |
| **Hot Spots / Recalcitrant Zone** | Areas of highest or persistent VOC concentrations | - Existing shallow wells S13-MW1, S13-MW8<br>- Existing deep well S13-MW15 | - Estimate VOC reduction over time.<br>- Estimate source mass dissolution rate.<br>- Determine need for additional remedial action to reduce VOC concentrations to desired levels. | - VOCs<br>- Geochemical parameters. | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5.<br>- Every 3 years for years 6 to 10.<br>- Every 6 years thereafter. |
| **Plume Centerline** | Areas of high concentration and mobility along plume core flowpaths. | - Flowpath 1: S13-MW1 ==> S13-MW8 ==> S13-MW15/17 ==> S13-MW19. | - Estimate reduction of VOC plume over time and distance (i.e., NA rate, decay rate)<br>- Calculate reductions in VOC mass and concentrations. | - VOCs<br>- Geochemical parameters. | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5.<br>- Every 3 years for years 6 to 10.<br>- Every 6 years thereafter. |
| **Plume Boundaries/ Sentry Wells** | Areas sidegradient and downgradient outside plume. Designated points of compliance between plume boundaries and possible receptors. | - Existing shallow wells S13-MW6, S13-MW11, S13-MW16. | - Detect unacceptable plume expansion and changes in groundwater flow direction. | - VOCs<br>- Geochemical parameters. | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5.<br>- Every 3 years for years 6 to 10.<br>- Every 6 years thereafter. |
| **Background** | Areas upgradient, sidegradient or downgradient of the VOC plume, representative of uncontaminated geochemical settings. | - Existing upgradient shallow well S13-MW18. | - Determine variability of geochemical conditions outside VOC plume.<br>- Measure geochemical setting. | - VOCs<br>- Geochemical parameters. | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5.<br>- Every 3 years for years 6 to 10.<br>- Every 6 years thereafter. |
| **Groundwater Hydrology** | All Site 1111 areas. | - Entire GW MNA monitoring network (15 wells) | - Determine that there are no changes in groundwater flow rates and directions that would impact plume stability.<br>- Estimate hydraulic gradients. | - Groundwater elevations. | - Semi-annually for first two years to coincide with dry and wet seasons.<br>- Annually for years 3 to 5.<br>- Every 3 years for years 6 to 10.<br>- Every 6 years thereafter. |
| **Summary** | | **- 15 Existing wells** | | | |

Table 4-3

12 Area, Site 13 Summary of Detailed Analysis of Alternatives
OU 5 FS, MCB Camp Pendleton, California

| NCP Criterion | Alternative 12A-1<br>No Action | Alternative 12A-2<br>Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal | Alternative 12A-3<br>Monitored Natural Attenuation with Alternative 12A-2 |
|---|---|---|---|
| **Overall Protection of Human Health and the Environment** | | | |
| Human Health Protection | No reduction in baseline risks. No control of exposure pathways. Not protective of human health. | Reduces potential risks from groundwater ingestion or dermal absorption by limiting access to groundwater and conducting periodic monitoring. Protective of human health. | Reduces potential risks from groundwater ingestion or dermal absorption by limiting access to groundwater and conducting periodic monitoring. Long-term risk would be reduced as the contaminant concentrations naturally attenuate over time. Protective of human health. |
| Environmental Protection | Local habitat not impacted by current conditions. No current environmental threats to threatened or endangered species. Existing groundwater contamination would remain in the short term and reduced over time by natural attenuation. Protective of the environment. | Local habitat not impacted by current conditions. No current environmental threats to threatened or endangered species. Existing groundwater contamination would remain in the short term and be reduced over time by natural attenuation. Protective of the environment. | Local habitat not impacted by current conditions. No current environmental threats to threatened or endangered species. Existing groundwater contamination would remain in the short term and be reduced over time by natural attenuation. Protective of the environment. |
| **Compliance with ARARs** | | | |
| Chemical-Specific ARARs | Would not meet groundwater standards in the short-term. Concentrations expected to remain indefinitely if source is not removed. | Would not meet groundwater standards, in the short-term. Expected to meet groundwater ARARs within 20 years. | Would not meet groundwater standards, in the short-term. Expected to meet groundwater ARARs within 20 years. |
| Location-Specific ARARs | None. | None. | None. |
| Action-Specific ARARs | Does not meet action-specific ARARs of monitoring. | Meets all action-specific ARARs. | Meets all action-specific ARARs. |
| **Long-Term Effectiveness and Permanence** | | | |
| Magnitude of Residual Risk<br>• Groundwater ingestion or dermal absorption by future users | Does not limit long-term exposure. | Limits long-term exposure by restricting groundwater use. | Limits long-term exposure by restricting groundwater use. |

Table 4-3

12 Area, Site 13 Summary of Detailed Analysis of Alternatives
OU 5 FS, MCB Camp Pendleton, California

| NCP Criterion | Alternative 12A-1<br>No Action | Alternative 12A-2<br>Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal | Alternative 12A-3<br>Monitored Natural Attenuation with Alternative 12A-2 |
|---|---|---|---|
| **Long-Term Effectiveness and Permanence (continued)** | | | |
| Adequacy and Reliability of Controls | Provides no reliable or adequate controls. | Provides adequate and reliable controls to reduce long-term risks through access restriction. | Provides adequate and reliable controls to reduce long-term risks through monitoring and access restriction. |
| Need for 5-Year Review | No review would be done. | Review would be required to confirm the plume is not migrating off site. | Review would be required to monitor the effectiveness of natural attenuation processes. |
| **Reduction of Toxicity, Mobility, or Volume Through Treatment** | | | |
| Treatment Process Used | None. | None. | None. |
| Amount Destroyed or Treated | None. | None. | None. |
| Reduction of Toxicity, Mobility, or Volume | Natural attenuation. | Natural attenuation. | BTEX 0.3 kg; TCE 0.4 kg. |
| Irreversible Treatment | None. | None. | None. |
| Type and Quantity of Residuals Remaining After Treatment | No groundwater treatment. | Contaminant concentrations remaining in the groundwater would be at or below acceptable levels (i.e., remedial goals). | Contaminant concentrations remaining in the groundwater would be at or below acceptable levels (i.e., remedial goals). |
| Statutory Preference for Treatment | Does not satisfy the statutory preference for treatment. | Does not satisfy the statutory preference for treatment. | Does not satisfy the statutory preference for treatment. |
| **Short-Term Effectiveness** | | | |
| Community Protection | Zero incremental risk because no remedial action would be implemented. | Short-term risk to the community would not be increased by this remedial action. | Short-term risk to the community would not be increased by this remedial action. |

Table 4-3

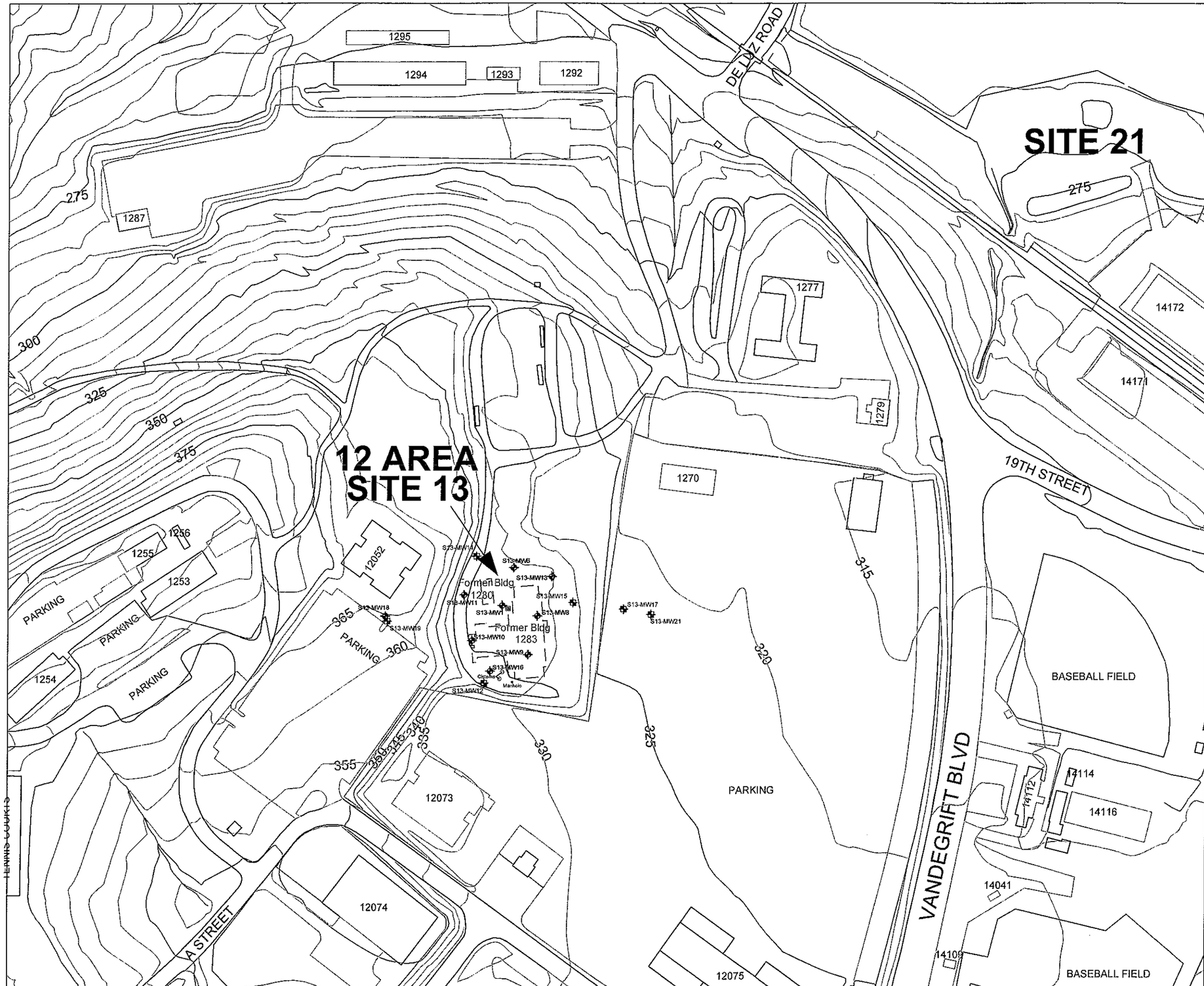
**12 Area, Site 13 Summary of Detailed Analysis of Alternatives**
**OU 5 FS, MCB Camp Pendleton, California**

| NCP Criterion | Alternative 12A-1 | Alternative 12A-2 | Alternative 12A-3 |
|---|---|---|---|
| | No Action | Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal | Monitored Natural Attenuation with Alternative 12A-2 |
| **Short-Term Effectiveness (continued)** | | | |
| Worker Protection | Not applicable because no remedial action would be implemented. | PPE would be used during sampling. | Potential short-term risks to site workers associated with dust emissions and direct contact with contaminated groundwater during well construction. PPE would be used during construction and sampling activities. |
| Environmental Impacts | None. Continued impact from existing conditions. | None. Continued impact from existing conditions. | None. Continued impact from existing conditions. |
| Time Until Action Is Completed | None. No action is taken. | 20 years. | 20 years |
| **Implementability** | | | |
| Ability to Construct and Operate | No construction or operation is involved. | Land-use controls to restrict future access to groundwater are easy to implement. Monitoring wells are easy to construct, sample, and maintain. | Monitoring wells are easy to construct, sample, and maintain. |
| Ease of Doing More Action if Needed | Because no action is involved, there would be no interference with future actions. | Land-use controls and groundwater sampling could be easily implemented. | Additional groundwater monitoring wells or treatment could be easily implemented. |
| Ability to Monitor Effectiveness | Not applicable because no remedial action would be implemented. | Effectiveness would be monitored through well sampling and analysis. | Effectiveness would be monitored through well sampling and analysis. |
| Ability to Obtain Approvals and Coordinate with Other Agencies | No approval is necessary. | No permits are required. | Well permits are required for new wells. |
| Availability of Services and Capacities | Not applicable. | Monitoring well equipment is commercially available. | Monitoring well equipment is commercially available. |
| Availability of Equipment, Specialists, and Materials | Not applicable. | Monitoring equipment and personnel are commercially available. | Monitoring equipment and personnel are commercially available. |
| Availability of Technologies | Not applicable. | Technology proven and available. | Technology proven and available. |

Table 4-3

12 Area, Site 13 Summary of Detailed Analysis of Alternatives
OU 5 FS, MCB Camp Pendleton, California

| NCP Criterion | Alternative 12A-1 | Alternative 12A-2 | Alternative 12A-3 |
|---|---|---|---|
| | No Action | Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal | Monitored Natural Attenuation with Alternative 12A-2 |
| **Cost** | | | |
| Capital Cost | $0 | $96,100 | $122,500 |
| Cumulative O&M Cost | $0 | $228,200 | $316,200 |
| Total Cost | $0 | $324,300 | $438,700 |




Legend

Shallow Groundwater Monitoring Well

Deep Groundwater Monitoring Well

N

0 100 200

Scale in Feet

**Figure 4-1**

**12 Area, Site 13**
**Site Location Map**

MCB Camp Pendleton, California

**PARSONS**

Pasadena, CA

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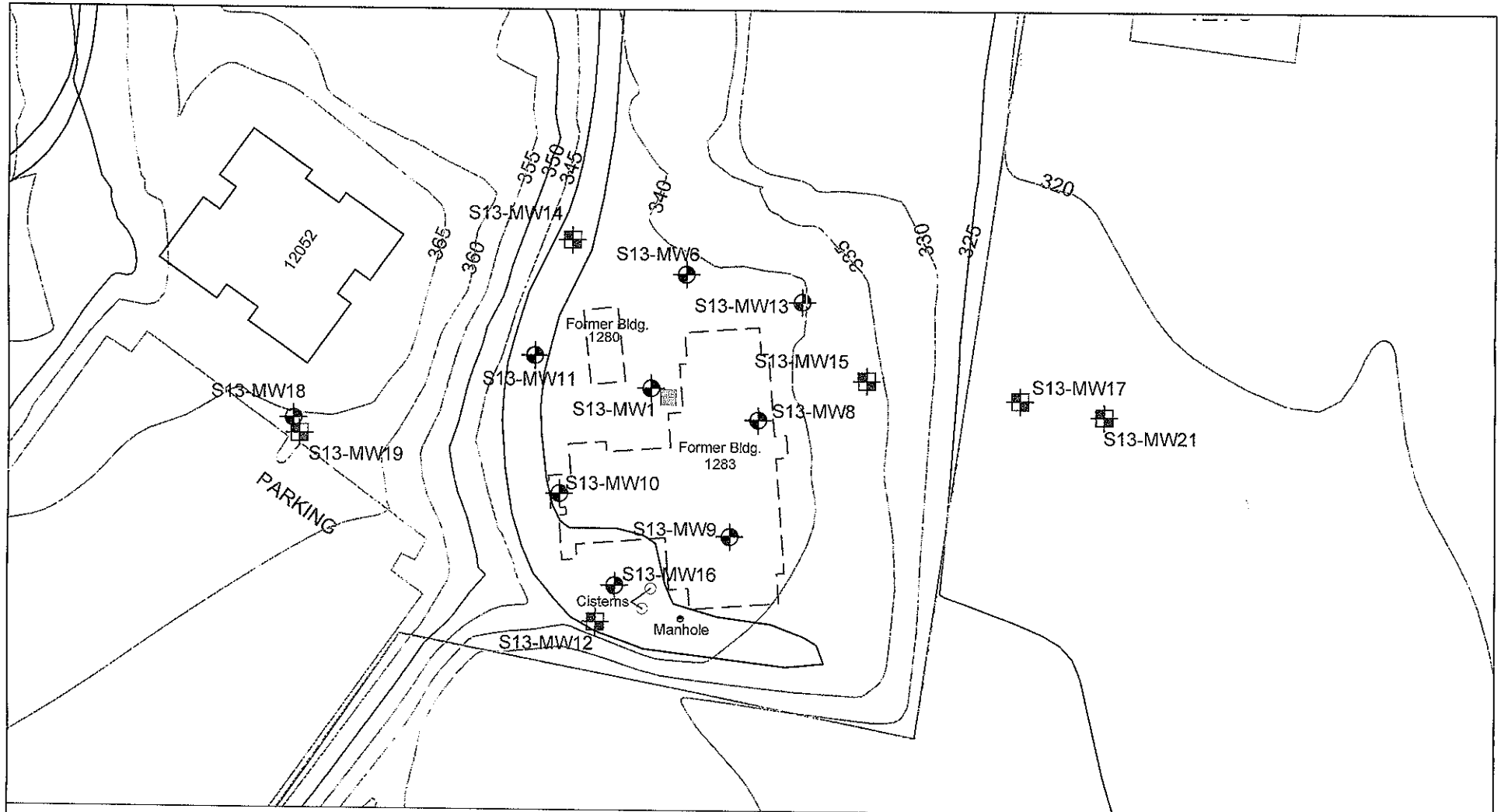


Legend

Shallow Groundwater Monitoring Well

Deep Groundwater Monitoring Well

N

0 100 200

Scale in Feet

**Figure 4-2**

**12 Area, Site 13**
**Groundwater Monitoring**
**Well Locations**

MCB Camp Pendleton, California

**PARSONS**

Pasadena, CA

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| Groundwater General Response Actions | Remedial Technology | Process Options | Description | Screening Comments |
|---|---|---|---|---|
| No Action | None | None | No action is taken. | Required for consideration by NCP. |
| Institutional Control | Use Restrictions | Use Restrictions | Restrict use of groundwater in the contaminated area. | Potentially applicable. |
| | Well Head Treatment | Ex situ Treatment at Extraction Well Point | Install wellhead treatment unit for water supply wells impacted by contamination. | Not applicable, no wells impacted. |
| | Monitoring | Periodic Sampling of Groundwater MWs | Periodic groundwater monitoring is conducted. | Potentially applicable. |
| | | Monitored Natural Attenuation | Natural processes are allowed to reduce contaminant concentrations to acceptable levels. | Potentially applicable. |
| | Alternate Water Supply | City Water Supply | Connect affected users to city water supply. | Not applicable due to relative isolation of Base from any cities. |
| | | New On-Base Supply Well | Install new water supply well in areas not impacted by the contamination. | Not applicable due to site conditions. |
| Containment | Structural Barriers | Slurry Wall | Impermeable soil (or cement) bentonite barrier built in flowpath of contaminant. | Not applicable due to site conditions. |
| | | Grout Curtain | Pressure injected grout in a regular pattern of drilled holes. | Not applicable due to site conditions. |
| | | Sheet Piling | Steel sheets permanently driven into the ground to create impermeable wall. | Not applicable due to site conditions. |
| | | Vibrating Beam Wall | I-beams driven into ground to desired depth and cavity filled with grout. | Not applicable due to site conditions. |
| | Hydraulic Barriers | Groundwater Pumping | Adjustment of groundwater levels through pumping to control plume migration. | Not applicable due to site conditions. |
| | Subsurface Drains | Interceptor Trench | Perforated pipes in trenches intercepting plume; collect contaminated groundwater. | Not applicable due to site conditions. |

Process Option Screened Out During Initial Screening

**Figure 4-3**

**12 Area, Site 13**
**Initial Screening of Technologies for Groundwater**
**(Page 1 of 4)**

MCB Camp Pendleton, California

PARSONS

Pasadena, California

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| Groundwater General Response Actions | Remedial Technology | Process Options | Description | Screening Comments |
|---|---|---|---|---|
| Extraction/Removal | Groundwater Pumping | Extraction Wells | Groundwater pumping using individual extraction wells. | Not applicable for the site conditions. |
| | | Well Points | Groundwater pumping using matrix of driven wells connected to single pump. | Not applicable for the site conditions. |
| | | Dual Phase Extraction | High vacuum liquid/vapor treatment system designed to remove contaminants from above and below the water table. | Not applicable for the site conditions. |
| | Product Recovery | Passive Skimmer | Collects product without collecting groundwater. | Potentially applicable. |
| Discharge | Surface Discharge | On-Base w/o Treatment | Extracted untreated groundwater discharged to on-Base Stream. | Not applicable for the site conditions. |
| | | On-Base w/ Treatment | Extracted treated groundwater discharged to on-Base stream. | Potentially applicable; but no extracted groundwater and not needed at this time. |
| | | Off-Base w/ or w/o Treatment | Extracted groundwater discharged to off-Base stream or Pacific Ocean. | Not applicable for the site conditions. |
| | Treatment Plant | On-Base Facility | Extracted untreated groundwater discharged to on-Base treatment plant. | Not applicable. On-Base facility cannot effectively treat solvents. |
| | | Publically Owned Treatment Works | Extracted untreated groundwater discharged to POTW. | Not applicable. Nearest POTW facilities are limited to municipal sewage treatment. |
| | Subsurface Discharge | Injection Wells | Extracted untreated groundwater reinjected back into aquifer plume. | Not applicable for the site conditions. |
| In Situ Treatment | Physical | Air Sparging | Air or nitrogen is injected into groundwater to volatilize, collect, and treat VOC plume. | Not applicable for the site conditions. |
| | | In Well Air Stripping | Air or nitrogen is injected into groundwater to volatilize, collect, and treat VOC plume. | Potentially applicable. |

Process Option Screened Out During Initial Screening

**Figure 4-3**

**12 Area, Site 13**
**Initial Screening of Technologies for Groundwater**
**(Page 2 of 4)**

MCB Camp Pendleton, California

**PARSONS**

Pasadena, California

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| Groundwater General Response Actions | Remedial Technology | Process Options | Description | Screening Comments |
|---|---|---|---|---|
| In Situ Treatment (continued) | Chemical | Chemical Oxidation | Chemical reagents are injected into groundwater to destroy contaminants by converting them to innocuous compounds. | Not applicable for site conditions. |
| | | Permeable Reactive Barrier | Intercepting barrier packed with reactive material to remove contaminants from groundwater as it flows through barrier. | Not applicable for site conditions. |
| | | ZVI Treatment | Reactive material injected in source area to reduce contamination. | Not applicable for site conditions. |
| | Biological | Enhanced Bioremediation | A specific material is injected into the groundwater to promote biodegradation of contaminants. | Not applicable for site conditions. |
| | | Phytoremediation | Uses plants to remove, transfer, stabilize, and destroy contamination in groundwater, surface water, and leachate. | Not applicable for site conditions. |
| Ex Situ Treatment | Physical | Air Stripping | Volatile contaminants are stripped off by contacting groundwater with air in a high interfacial area system. | Potentially applicable; but no extracted groundwater and not needed at this time. |
| | | Liquid Phase Carbon Adsorbtion | Groundwater is pumped through one or more vessels containing activated carbon to which dissolved organic contaminants adsorb. | Potentially applicable; but no extracted groundwater and not needed at this time. |
| | | Membrane Separation | Separates contaminants from their medium by preventing them from passing through semipermeable membrane. | Not applicable. |
| | | Flow Equalization | Interaction between groundwater from various sources to equalize variations. | Potentially applicable as a support technology; but no extraction retained. |
| | | Sedimentation | Solids removal via pH adjustment, chemical addition, coagulation, or flocculation. | Potentially applicable as a support technology; but no extraction retained. |
| | | Filtration | Removal of suspended solids by forcing solution through porous a medium. | Potentially applicable as a support technology; but no extraction retained. |
| | | Liquid-Liquid Extraction | Separation of constituents from a liquid solution by contact with another liquid in which the constituents are more soluble. | Not applicable for the site conditions. |

Process Option Screened Out During Initial Screening

**Figure 4-3**

**12 Area, Site 13**
**Initial Screening of Technologies for Groundwater**
**(Page 3 of 4)**

MCB Camp Pendleton, California

**PARSONS**

Pasadena, California

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| Groundwater General Response Actions | Remedial Technology | Process Options | Description | Screening Comments |
|---|---|---|---|---|
| Ex Situ Treatment (continued) | Chemical | Ion Exchange | Ions on a solid-phase medium selectively swap with ionic contaminants in the groundwater facilitating removal. | Not applicable for site contaminants. |
| | | Chemical Precipitation | Precipitation of contaminants via chemical reaction. | Not applicable for site contaminants. |
| | | Oxidation-Reduction | Raising or lowering oxidation state of compound via chemical addition. | Not applicable for site contaminants. |
| | | Chemical Dechlorination | Use of chemical reactions to dehalogenate chlorinated compounds. | Not applicable for site conditions. |
| | | Coagulation/Flocculation | Reagents added to neutralize surface charges of fine contaminant particles, entrapping them and facilitating removal. | Not applicable for site conditions. |
| | | Coprecipitation | Removal of ionic compounds via adsorbtion onto another precipitating solid. | Not applicable for site contaminants. |
| | | U/V Oxidation | Destroying organic contaminants via simultaneous application of ultraviolet light and strong oxidizer. | Not applicable for site conditions. |
| | Biological | Fixed-Film Bioreactor | Biomass attached to inert support media is used to degrade organics in groundwater. | Not applicable for site contaminants. |
| | | Suspended Growth Bioreactor | Bacteria in suspension in aqueous media is aerated in a tank to degrade organics and create new bacteria. | Not applicable for site contaminants. |

Process Option Screened Out During Initial Screening

Figure 4-3

12 Area, Site 13
Initial Screening of Technologies for Groundwater
(Page 4 of 4)

MCB Camp Pendleton, California

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| Groundwater General Response Actions | Remedial Technology | Process Options | Effectiveness Rating | Implementability Rating | Cost Rating |
|---|---|---|---|---|---|
| No Action | None | None | Low; does not achieve RAOs or proposed remediation goals. | High; no action is needed. | High. |
| Institutional Control | Use Restrictions | Use Restrictions | Low to Moderate; contamination is not reduced. Effectiveness to reduce risk depends on continued future implementation. | High; readily implementable. | High. |
| | Monitoring | Periodic Sampling of Groundwater MWs | Moderate; effective for monitoring plume size and concentrations and for early warning of contaminant migration. | High; monitoring network already exists; potentially acceptable to agencies because of low contaminant concentrations and absence of current receptors. | Moderate to High. |
| | | Monitored Natural Attenuation | Moderate; method is reliable and proven. If implemented alone it is a long-term process. | High; additional wells can be easily installed; potentially acceptable to agencies because of low contaminant concentrations and absence of current receptors. | Moderate. |
| Extraction/Removal | Product Recovery | Passive Skimmer | High; Passive product recovery is an effective, reliable, and proven technology for removing product from groundwater. | High; implemented at numerous sites, materials readily available. | Moderate. |
| In Situ Treatment | Physical | In Well Air Stripping | Low; air or nitrogen is injected into groundwater to volatilize, collect, and treat VOC plume, field testing has shown limited effectiveness. | Moderate; limited full-scale implementation. | Moderate. |

Process Option Screened Out During Evaluation

**Figure 4-4**

**12 Area, Site 13**
**Evaluation of Process Options for Groundwater**

MCB Camp Pendleton, California

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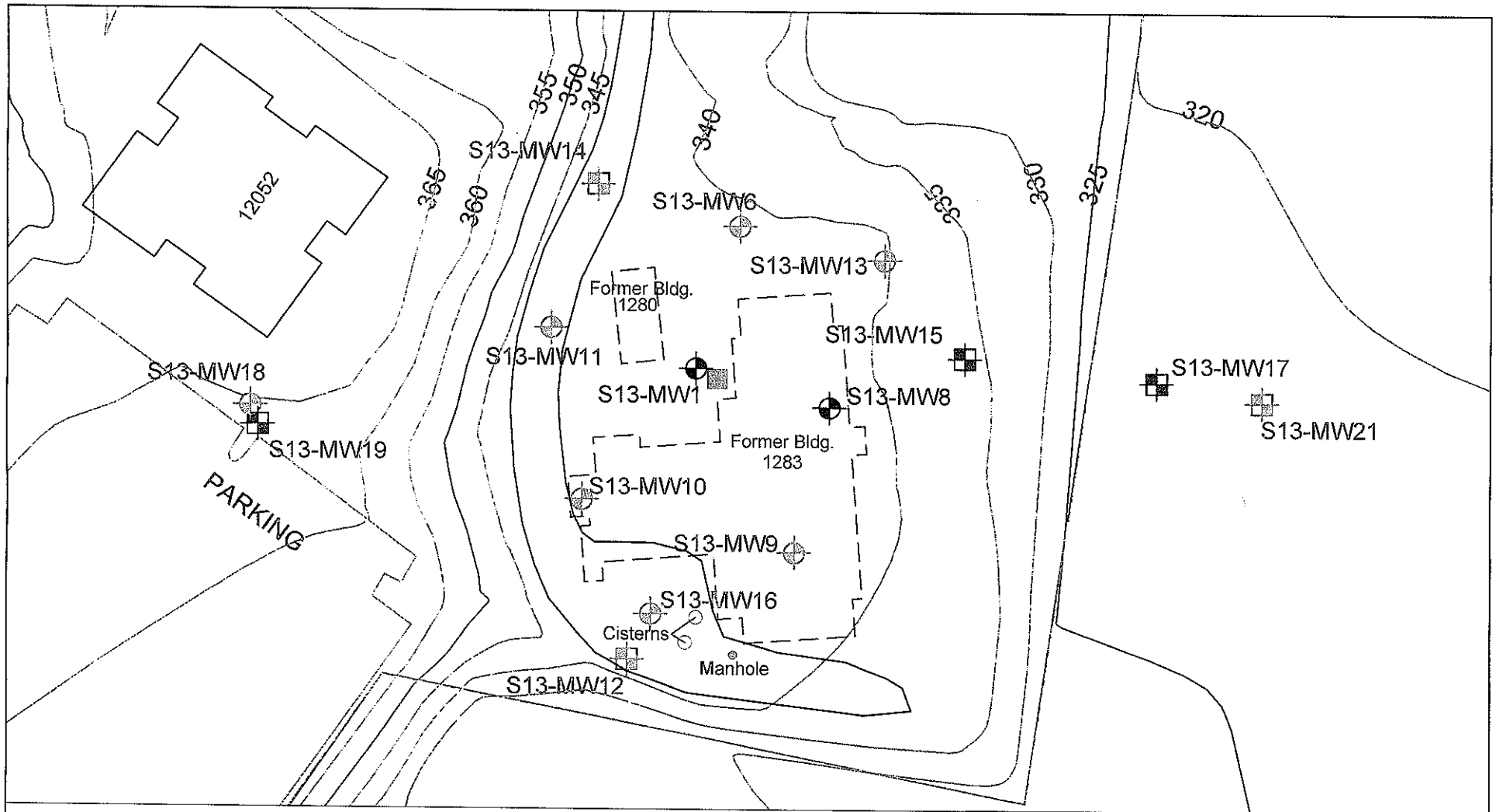


Legend

- Shallow Groundwater Monitoring Well Not Included in Initial Groundwater Monitoring Network
- Deep Groundwater Monitoring Well Not Included in Initial Groundwater Monitoring Network
- Shallow Groundwater Monitoring Well Included in Initial Groundwater Monitoring Network
- Deep Groundwater Monitoring Well Included in Initial Groundwater Monitoring Network

N

0 80 160

Scale in Feet

**Figure 4-5**

**12 Area, Site 13**
**Proposed Monitoring Network for Institutional Controls and Groundwater Monitoring**

MCB Camp Pendleton, California

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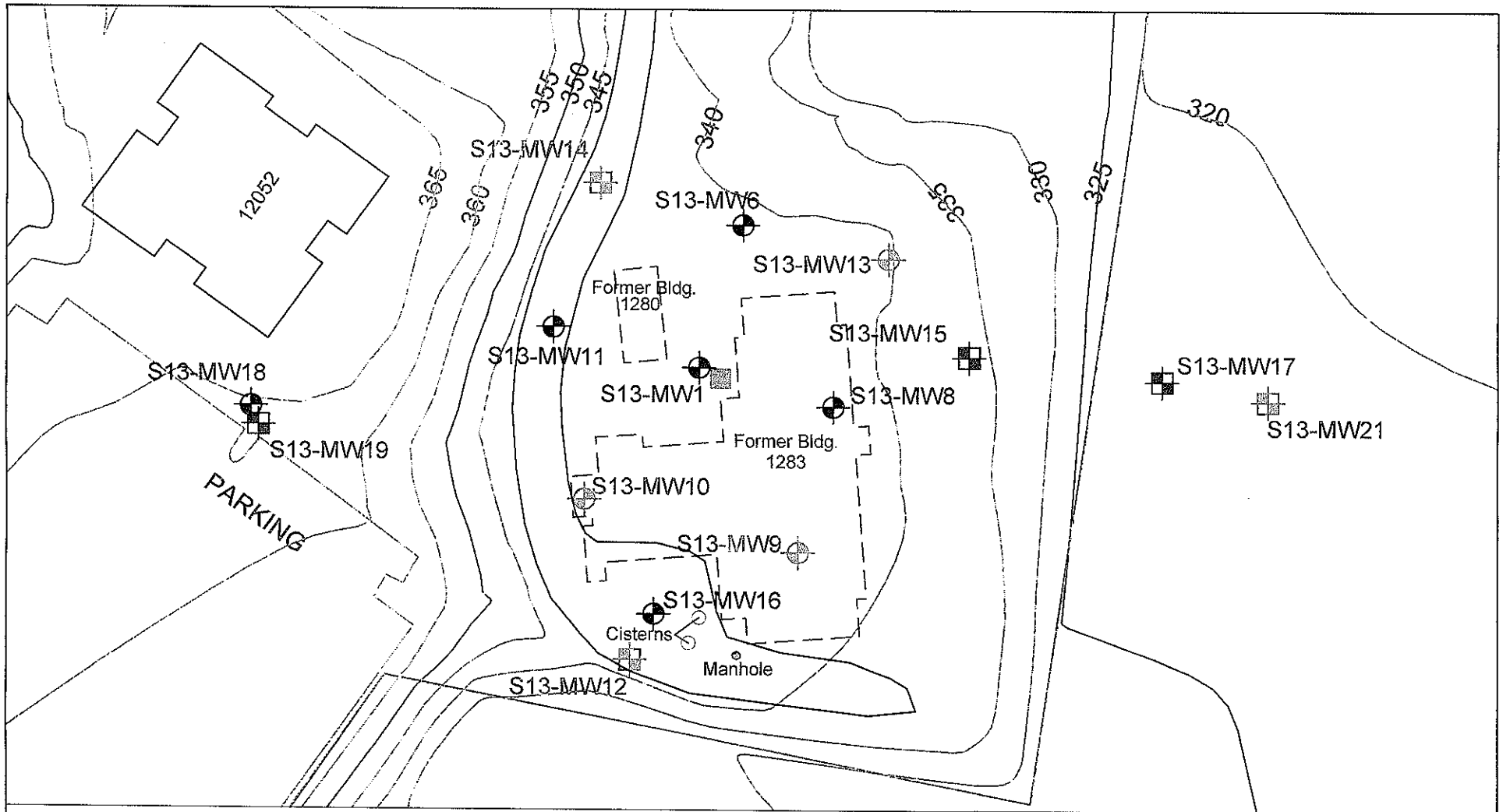


Legend

- Shallow Groundwater Monitoring Well Not Included in Groundwater Monitoring Network
- Deep Groundwater Monitoring Well Not Included in Groundwater Monitoring Network
- Shallow Groundwater Monitoring Well Included in Groundwater Monitoring Network
- Deep Groundwater Monitoring Well Included in Groundwater Monitoring Network

N

0 80 160

Scale in Feet

**Figure 4-6**

**12 Area, Site 13**
**Proposed Monitoring Network for MNA**

MCB Camp Pendleton, California

**PARSONS**

Pasadena, CA

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# ATTACHMENT 1
# RESPONSE TO AGENCY COMMENTS ON THE DRAFT OPERABLE UNIT 5 FEASIBILITY STUDY

**DRAFT OPERABLE UNIT 5 FEASIBILITY STUDY**
**FOR SITES 1A-1, 21, 1111, AND 12 AREA, SITE 13**
**MARINE CORPS BASE CAMP PENDLETON, CALIFORNIA**

**RESPONSE TO COMMENTS FROM**

**THE US ENVIRONMENTAL PROTECTION AGENCY (USEPA) REGION IX**
**(RECEIVED 13 APRIL 2005)**

***[As discussed during the FFA meeting held 24 May 2005, comments and responses relating to Site 21 have been removed from this document and will be addressed separately in a Technical Meeting and included in a separate report for Site 21. Section numbers in the responses to comments on Site 1111 and 12 Area, Site 13 reflect the section numbers of the draft final document. The remaining comments have been sequentially numbered to facilitate discussion.]***

***[The following comments have been sequentially numbered to facilitate discussion.]***

(The comments on the Draft Operable Unit 5 Feasibility Study are categorized into Major Comments that likely require discussion and resolution among the regulatory agencies and the Navy, and Specific Comments that address technical clarifications and inconsistencies in the Feasibility Study (FS) text. Minor Comments are also provided to resolve typographical errors or possible misstatements that should be corrected.)

**SITE 1A-1**

**MAJOR COMMENTS (SITE 1A-1)**

**Comment 1:** Four alternatives are developed for Site 1A-1 soil in this Feasibility Study (FS). However, the FS indicates that a possible fifth alternative for this site is being considered by the Navy, but this alternative is not included as a formal alternative in this document at this time pending further review and analysis. This approach implies that the FS is incomplete and to be complete all alternatives must be evaluated together. The proposal to describe this fifth alternative in a addendum document if it is determined to be viable would not allow adequate comparison with the other alternatives, and is therefore inconsistent with the goals of the CERCLA process. Specifically, if the Navy wishes to consider the possibility of combining waste soils from Site 1A and Site 1A-1 and capping the combined waste as a fifth alternative, please revise the FS to include a description and evaluation of this alternative, complete with the implementability issues and uncertainties that have been identified. Alternatively, the Navy could reissue the draft FS allowing for adequate comparison with other alternatives.

> **Response:** If the DON determines that combining wastes from Sites 1A and 1A-1 is viable, a supplemental FS would be necessary, which would be reviewed by the FFA Team.

**Comment 2:** The FS concludes that an evapotranspiration (ET) cover is the only suitable capping option for Site 1A-1, and the evaluation of different cover options is not included in the FS. Also, according to Figure 2-3, an asphalt cap or concrete cap were

the only other capping alternatives considered. The comparison of different capping alternatives such as flexible membranes, geosynthetic clay, or the 'prescriptive' cover (low permeability soil barrier) for example, in addition to the ET cover, should be presented in this FS. The evaluation of capping alternatives, which allowed the Navy to select the ET cover design, should be transparent to the reviewers. Therefore, please revise the FS to include several feasible cover designs in the preliminary screening of technology process options in terms of effectiveness, implementability, and cost.

**Response:** The FS does provide a comparative screening evaluation of flexible membrane liner designs, asphalt/concrete covers, and engineered soil covers, based on the desired functionality of the cap, the site setting, and the projected future site use. The FS concluded that an asphalt/concrete cap would not be appropriate for the site's projected land use. Also, given the site topography, significant grading of the existing foundation and an 18-inch thick minimum top layer of clean soil to allow sufficient room for vegetation growth, would be required to provide a suitable base and adequate sheet drainage for a flexible membrane cover design. For these reasons, a flexible liner cover design (including a RCRA "prescriptive" cap design) was determined to be no more cost-effective and to require more long-term maintenance than an equivalent engineered soil cover design. Section 2.4.3 and Figure 2-3, have been revised to clarify and expand on these points and to include a more detailed comparative evaluation of the ET cover with other viable soil cover designs including the use of a monolithic soil cover (low permeability soil barrier).

**Comment 3:** Alternative 1A1-4: Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal relies on an on-Base Thermal Treatment Unit (TTU) to stabilize the California-hazardous soil to nonhazardous status and the RCRA-hazardous soil to California-hazardous status prior to off-Base transport and disposal. The FS asserts that none of the material would be classified or manifested as RCRA waste and would not be subject to the universal treatment standards of the land disposal restrictions. However, stabilization was determined to be infeasible during the screening of technology options. It is not clear what impact this will have on the disposal options for excavated soil. Please revise the FS to discuss whether RCRA-hazardous soil is anticipated at the site and what disposal issues arise for this material since pre-treatment is not feasible.

**Response:** The TTU proposed in Alternative 1A1-4 to pre-treat California-hazardous soil to nonhazardous status and RCRA-hazardous soil to California-hazardous status prior to off-Base transport and disposal is different and separate from the ex situ solidification/stabilization (S/S) process option evaluated during the screening of technology options and determined to be infeasible.

The on-Base waste pretreatment prior to off-site transportation and disposal is a common practice to reduce waste mobility and overall disposal costs. This option is used for off-Base disposal only. The soil excavated from Site 1A-1 would be pre-treated on site using a transportable treatment unit (not a thermal treatment unit) for stabilization prior to transport and off-Base disposal. As identified in the Alternative 1A1-4, the soil pretreatment will reduce materials identified as RCRA hazardous based on in situ sampling to California hazardous levels. Additionally, it will reduce materials identified as California hazardous based on in situ sampling to non-hazardous. These materials will then be

transported off Base for disposal based on results from post treatment confirmation sampling.

The S/S option, evaluated in Section 2.4.7.1.3, is a process that generates material for the placement in or beneath roadways on Base. This option was determined to be not economically feasible due to the large amounts of antropogenic debris present in the waste, which would make it ineligible for reuse as construction fill material. Roadway material cannot contain large volumes of biodegradable material that will decrease the long term viability of the roadway.

**Comment 4:** The cost estimates do not include present value analysis. Present value analysis is useful in comparing costs of alternatives that occur over different time periods. In order to better compare the costs of alternatives with long operation and maintenance periods with those with shorter or no operation and maintenance periods, please revise the FS to include present value analysis in accordance with the EPA guidance *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, July 2000.

**Response:** For estimating costs of each remedial alternative, both a net present value (NPV) analyses and a non-NPV method were used. After consideration of the merits of each method, DON decided that the non-NPV method represents a more realistic estimate. This is because the costs incurred to the government to implement a given remedial alternative are paid on a year-by-year basis. The NPV method is more appropriate in situations where the full cost of remediation is paid up-front in an escrow-type of account, which earns interest over time. The introductory text in the cost appendix has been modified to explain this reasoning.

**Comment 5:** The FS proposal to select the lowest value among the human health, ecological, or vadose zone (i.e., threat-to-groundwater) remedial goals developed for contaminants of concern (COCs) in soil is consistent with choosing a conservative remedial approach. This method of selecting cleanup goals is sometimes preferable; however, if a more efficient approach (i.e., selecting cleanup goals based on the category receptors of most concern at the site) will provide for adequate remediation of the site, the potential exists to expedite cleanup and reduce cost. For example, a site similar to Site 1A-1 and Site 1111 where ecological habitat is present and the site is not proposed for human use the site could be selected for ecological risk-driven remediation. Selecting remedial goals based on the category of receptors relevant to the site (e.g., human, ecological, or groundwater receptors) may achieve the necessary level of protection and is likely to more cost-efficient. Please consider revising the FS to select remedial goals based on the primary receptors at each site. If the latter approach is taken, please document the proposed criteria, institutional controls required, and the rationale for discussions with and approval of the regulatory agencies.

**Response:** The DON agrees with selecting RGs based on the receptor categories of most concern at a site. In essence, the FS already follows a very similar approach in that the RGs selected for a receptor category (e.g., human health risk) only apply to that category. For instance, if soil contamination at a site poses a risk of exposure to human and ecological receptors and a threat to groundwater, the lowest RG value for each category would be selected to protect receptors in that category. If the soil contamination only poses a threat to

groundwater and no human or ecological exposure risk, the lowest RG among the groundwater protection category would be selected. Generally, ecological risk soil cleanup goals are more stringent than soil cleanup goals for groundwater protection and control the selected RGs.

**Comment 6:** The definition of human health remedial goals as the higher of the human health based concentrations or background values; and of ecological remedial goals as the higher of the preliminary ecological remedial goals or background concentration may not select the most protective approach, usually favored during the RI/FS process. Definition of background values as remedial goals may be appropriate if risk managers account for balancing factors such as the probability of unrestricted re-use being unlikely. Please address this issue by discussing factors the risk management team considered during the remedial goal recommendation process and if/when regulatory input was/will be incorporated.

**Response:** Background concentrations of inorganics were included in the criteria used to select remedial goals since as stated in USEPA's (2002) *Role of Background in the CERCLA Cleanup Program*, "Generally, under CERCLA, cleanup levels are not set at concentrations below natural background levels." This approach has considerable precedence at Camp Pendleton and across California, and has been documented in the Records of Decision of previous OUs. In virtually every site cleanup situation, including the sites in this OU, remediation to background values would be appropriate for unrestricted land use.

Specific background-related concerns that stakeholders (e.g., USEPA) may have with a particular chemical-specific remedial goal proposed in the FS can be raised during: 1) this comment/response process; and 2) Federal Facility Agreement (FFA) team meetings. The FFA Team (which includes representatives from the San Diego Regional Water Quality Control Board [RWQCB], Department of Toxic Substances and Control [DTSC], USEPA Region 9, and Pendleton) meets periodically (approximately every two months), which provides opportunities for the project managers of the respective agencies to raise questions or issues, or pass along questions raised by their technical staff.

**Comment 7:** The discussion of selected Contaminants of Concern (COCs) is inconsistent throughout the report. Information presented in Appendix D indicates that human health COCs are limited to 2,3,7,8-tetrachlorodibenzo-p-dioxin and arsenic. Information presented by the text in the Executive Summary indicates that COCs for sites evaluated by this report include metals, pesticides, dioxins, and VOCs. No pesticides or VOCs are considered COCs for human or ecological receptors according to Appendices D or E; however, one SVOC is considered a COC for ecological receptors. Please clarify whether the reference to VOCs in the Executive Summary is a typographical error. Please provide the rationale for considering pesticides to be COCs. Please make the discussions of COCs throughout the report consistent.

**Response:** The statement in the Executive Summary regarding VOCs at Site 1A-1 refers to all the types of contaminants that have been detected at the site in a general sense, not the specific remedial COCs determined based on the results of the human health and ecological risk assessments presented in Appendices D and E. The text has been modified to refer to COPC (chemicals of potential concern) in the Executive Summary.

## SPECIFIC COMMENTS (SITE 1A-1)

**Comment 8: Section 2.4.3 Containment, Page 2-11:** The initial screening of containment actions concludes that capping is a feasible technology; however in the detailed analysis of alternatives, the FS refers to measures to be taken to ensure that waste materials and new cover soils are not subject to flooding from Pilgrim Creek and that portions of the cap would be designed in order to comply with RCRA requirements for hazardous waste TSD facilities located within a 100-year floodplain. None of these issues are discussed in the evaluation of the implementability of this technology. Please revise the discussion of containment technologies to include a discussion of how the proximity of the creek and potential for flooding may affect the implementability of capping at Site 1A-1.

> **Response:** Sections 2.4.3 Containment and 2.6.3.6 Detailed Analysis of Alternatives have been revised to address the potential for flooding from Pilgrim Creek, and the possible need to reinforce the cap or move a portion of the waste to higher ground.

**Comment 9: Section 2.6.2.4 Alternative 1A1-4: Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal, Page 2-24:** Please delete on-base chemical stabilization from this alternative, since it was determined to be inapplicable at this site. In addition, this section refers to the siting, location, and excavation for utilities, but it is not clear why utilities are required for a soil excavation alternative. Please review the reference to utilities, and clarify the purpose of these utilities, if applicable.

> **Response:** As discussed in the response to Comment 3, the TTU proposed for Alternative 1A1-4 to pre-treat California-hazardous soil to nonhazardous status and RCRA-hazardous soil to California-hazardous status prior to off-Base transport and disposal is different and separate from the ex situ solidification/stabilization (S/S) process option evaluated during the screening of technology options and determined to be impractical at this site.

**Comment 10: Section 2.6.3.6 Implementability, Alternative 1A1-4: Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal, Page 2-34:** The FS concludes that licensed disposal facilities capable of accepting the contaminated soil currently exist within California; however, this conclusion is based on the assumption that soil will be pre-treated using stabilization. Since stabilization was determined to be infeasible at this site, please review the availability of licensed disposal facilities capable of accepting the untreated contaminated soil.

> **Response:** Please refer to the responses to Comments 3 and 9.

**Comment 11: Section 2.7.1 Overall Protection of Human Health and the Environment, Page 2-36:** This section states that Alternative 1A1-2 Institutional Controls would be protective of ecological receptors. Please recognize that Institutional Controls would control human exposure pathways, but may not protect ecological receptors. Please revise this statement accordingly.

> **Response:** The text has been revised to state that "Alternative 1A1-2 would control human exposure pathways."

**Comment 12: Appendix D, Section D1, Human Health Risk-Based Preliminary Remediation Goals, Page D2:** The text on this page indicates that OEHHA published a new conservative slope factor for arsenic and concludes that this information is not relevant to the FS because the remedial goal (based on background concentrations) was unaffected. However, this is a risk management decision. For completeness and future reference, the FS should provide the old and new slope factors, discuss their implications regarding applicable remedial goals, and present all calculations performed to arrive at the conclusion in question.

> **Response:** Please refer to Table I-8 of the RI Report (Parsons, 2004a) for a listing of toxicity values and corresponding references that were inherently incorporated into the preliminary human health remedial goal methodology described in Appendix D of the FS. The referenced text (Appendix D, Section D.1, Page D-2) has been clarified to incorporate specific information on the requested RG calculations and now reads, "The preliminary human health-based RG for arsenic of 1.8 mg/kg (Table D-1) was based on a predicted risk level calculated using an oral slope factor of 1.5 $(mg/kg\text{-}day)^{-1}$. While CalEPA's Office of Environmental Health and Hazard Assessment (OEHHA) has since published a more conservative slope factor for arsenic (9.45 $[mg/kg\text{-}day]^{-1}$) which would result in a preliminary human health-based RG of 0.34 mg/kg (1.8*1.5/9.45), this value would not change the final remediation goal since regional background concentrations are well above the risk-based concentration and actual site remediation would use the background concentration of 4.6 mg/kg listed in Table D-1 in lieu of the human health-based preliminary RG of either 1.8 or 0.34 mg/kg."

**Comment 13: Appendix D, Section D2, Preliminary Remediation Goals for Unrestricted Land Use, Page D3:** The Marine Corps has previously stated that deed restrictions or institutional controls (ICs) are not favored at Camp Pendleton, and the reasons for this position is understood by the regulatory agencies. Therefore, conducting remediation considering the Marine Corps preference for unrestricted land use is of interest, and residential or unrestricted land use cleanup goals are included in the FS. The text in this section explains that although remediation will be targeted to attain industrial cleanup goals, the residential cleanup goals in Appendix D were included to evaluate whether, at the completion of remedial efforts, that remediation has met residential levels as well (See text in Section D2, Page D3). If remediation does not achieve the more stringent cleanup levels, please discuss whether site specific risk calculations may then be conducted to assist the Navy and regulatory agencies in selecting appropriate ICs, and how the agencies will be informed and allowed to participate in this risk management process. (Please see comment below regarding the term, "Preliminary Remediation Goals.")

> **Response:** Examples of ICs that would be considered if unrestricted land use cleanup goals are not attained are discussed throughout the FS and include implementing restrictions on the site's future development, access restrictions, and fencing. As discussed in Section 2.6.2.2 (as an example), "If institutional controls, or land use controls, are chosen as the selected remedy for this site, a detailed description of the institutional controls or land use controls will need to be included in the ROD and Remedial Action Plan (RAP). The DON memo titled Monitoring and Enforcement of Land Use Controls (U.S. Navy, 2003) provides specific items to be included in the ROD and RAP, including listing the parties

responsible for enforcing the land use controls, and the need for five-year reviews." Similar to the response to Comment 6, agencies will be informed and encouraged to participate in selecting appropriate ICs during the finalization of the FS, RAP, and ROD via the comment/response process and the regular FFA team meetings.

**Comment 14: Appendix D, Section D2.2, Input Assumptions, Page D4:** Insufficient information is provided regarding why input assumptions for preliminary Remedial Goals in Table D-2 differ from USEPA Region 9 assumptions. Please also recognize that the Navy's use of the term "Preliminary Remediation Goal" is confusing as the EPA has already published Preliminary Remediation Goals (PRGs), and the published EPA PRGs are quantitatively different from the Navy's "EPA PRGs." Please revise the text and tables to clarify (and possibly change) the Navy's use of the PRG term, and also to recognize that the EPA PRGs have been developed in the context of screening applications whereas the Navy's "EPA PRGs" are used in the context of comparisons and site specific decision making; it is also likely a misnomer to use the term "CalEPA PRG" since these data are not from the CalEPA. Please also compare the input data such that the respective risk calculations could be duplicated in future efforts (see above comment about site specific risk calculations,) and possibly include the published EPA PRG values in Table D-1 for a direct comparison with the Navy's calculated values.

**Response:** Detailed information and the supporting rationale on the differences in the algorithms and input assumptions used to calculate unrestricted land use risk-based preliminary cleanup levels relative to the USEPA Region 9 PRG methods are included in Sections D.2.1 and D.2.2.

Text has been revised to clarify the definition of the preliminary remedial goals (RGs) used when selecting the proposed RGs used to evaluate the remedial alternatives. The acronym "PRG" is only used when specifically referring to USEPA Region 9 PRGs and the phrase "preliminary RG" is used when selecting site-specific remedial goals. The draft final document has been reviewed for consistency.

USEPA Region 9 tap water preliminary remediation goals (PRGs) were used as one of the criteria when selecting groundwater RGs. For example, refer to the following text from Section 1.5.2: "In addition to drinking water standards and background, carcinogenic and noncarcinogenic preliminary tap water preliminary remedial goals (PRGs) established by the USEPA Region 9 were used as TBC criteria for Site 1111. These are useful in helping to determine what is protective at the site when a drinking water standard is not established."

The phrase "CalEPA PRG" has been replaced throughout the document with the phrase, "Preliminary RG based on CalEPA toxicity data" in order to minimize confusion.

The algorithms used to calculate unrestricted land use preliminary RGs were provided in Appendix D (Human Health Risk-Based Preliminary Remedial Goals). For clarity and in order to facilitate the potential need to duplicate the respective unrestricted land use risk calculations, tables have been included in Appendix D listing the chemical-specific toxicity factors, physical parameters (note that the toxicity factors and physical parameters were taken from Tables I-7

thru I-9 and I-38 thru I-40 of the RI [Parsons, 2004]) and other input assumptions described text of the FS.

**Comment 15: Appendix D, Section D2.2.2, Site-Specific Soil and Chemical Properties, Page D-5:** Site-specific soil parameters are presented in this section without a reference. Please discuss where this information originated and if regulatory concurrence with these numbers has been obtained.

**Response:** The site-specific soil parameters presented in Section D2.2.2 were derived from actual soil samples collected from the site for geotechnical analyses. These parameters are consistent with typical average values for silty sand published in the technical literature. Regulatory concurrence with these parameters is being sought as part of the regulatory agency review of the OU 5 FS Report.

**Comment 16: Appendix E, Section E3.2, Development of Ecological PRGs, Page E3-2, Antimony:** The implication that because most no-effect Remedial Goals are less than background concentrations, lab based toxicity assessments are not representative of real animals in the environment is not technically defensible. Laboratory toxicity tests are but one indicator of potential toxicity. Because the no-effect level is sometimes below background concentrations does not necessarily mean that toxicity tests are not representative of the real world. For example, it may mean that there is a gap between the low-effect level and the no-effect level that straddles the background level. Concluding that because background concentrations exceed most no-effects levels determined in the lab the values must be so overly conservative that they do not accurately approximate toxicity to animals in the environment is unjustified. It is not appropriate to imply that less sensitive Remedial Goals should be selected due to the conservative nature of toxicity assessments. Please remove this rationalization from each place it occurs and provide an adequate justification for selecting effects based Remedial Goals.

**Response:** The Base is home to a diverse assemblage of resident populations of organisms. This alone is ample, defensible evidence that these resident populations of plants and animals have evolved to successfully sustain multiple generations of existence in an environment that contains inorganic elements within a range of regional "background" concentrations. Laboratory toxicity testing creates an artificial environment (often with species that are not native to the site of interest) that is useful for indicating toxic effects as they occur in that artificial construct. However, a laboratory-derived result that indicates toxicity occurs at doses below naturally occurring environmental concentrations is contradicted by the generations of populations of organisms that are present in a natural environment.

Please note that the text makes no claim that "....the values must be *so overly* [emphasis added] conservative that...."

The justification for selecting a particular Remedial Goal is provided on page E2-2:

> *"The value selected as a site- and chemical-specific ecological PRG is the lowest of the ecoPRGs for any wildlife receptor,*

*derived using an effect-based TRV. The rationale is that if the maximum residual concentration is at or below the ecoPRG, then the exposure for a population of mobile receptors within that area would never be at concentrations greater than the PRG and the exposure-point concentration (e.g., the 95%UCL) would always be within an acceptable range of concentrations that would not result in effect-based HQ values greater than one."*

The selected Remedial Goal is the lowest effect-based concentration; during confirmation sampling, residual concentrations would have to be less than this value. Consequently, all residual concentrations would be less than that which results in the lowest dose associated with an adverse effect. The text has not been modified.

**Comment 17: Appendix E, Section E3.2, Development of Ecological PRGs, Page E3-2, Antimony:** The selection of 16 mg/kg as the ecological RG for antimony requires more justification. The rationale provided indicates that selection was based on the fact that 16 mg/kg is the lowest RG based on effects level, is 2 times the background concentration, and is the upper bound for acceptable RG values. Please specify the 1) criteria used to determine that 16 mg/kg is the upper bound of acceptable cleanup goals and 2) how selecting the lowest effects level RG, approximately two times greater than background, is protective of ecological receptors including special status species.

**Response:** The comment mis-states the text: 16 mg/kg is the upper-bound limit for an acceptable exposure-point concentration. That value, 16 mg/kg, is also the lowest of the effect-based ecoPRGs. The justification for selecting a particular Remedial Goal is provided on page E2-2:

*"The value selected as a site- and chemical-specific ecological PRG is the lowest of the ecoPRGs for any wildlife receptor, derived using an effect-based TRV. The rationale is that if the maximum residual concentration is at or below the ecoPRG, then the exposure for a population of mobile receptors within that area would never be at concentrations greater than the PRG and the exposure-point concentration (e.g., the 95%UCL) would always be within an acceptable range of concentrations that would not result in effect-based HQ values greater than one."*

The selected Remedial Goal is the lowest effect-based concentration; during confirmation sampling, residual concentrations would have to be less than this value. If exposure concentrations were greater than this value, then a derived Hazard Quotient would be greater than a value of one, and would indicate a potential concern. Establishing 16 mg/kg as the upper limit of acceptable concentrations at the site means that all residual concentrations would be less than that which results in the lowest dose associated with an adverse effect. The text has not been modified.

**Comment 18: Appendix E, Section E3.2, Development of Ecological PRGs, Page E3-2, Zinc:** The implication that conservatism is inherent to the toxicity assessment, excessively so for the essential nutrient zinc, lacks supporting information. The inference minimizes the potential toxicity of zinc to ecological receptors; however, if

information confirming that the essential nutrient status of zinc is applicable to the specific receptors of concern, the statement would be appropriate. Please either include this information or remove the implication from each place it is found in the report.

**Response:** The comment over-states the text; the text is "*perhaps* [emphasis added] excessively so," not the level of assertion stated in the comment. A statement that zinc is an essential nutrient for mammals and birds should not raise concern for a biologist. However, excessive concentrations of zinc, *e.g.*, as a result of industrial pollution, may overwhelm homeostatic mechanisms and elicit toxicity. The following has been added as the last sentence in the referenced paragraph:

> *"The nutritional needs of the wildlife receptors are not specifically known, however, the long-term maximum tolerable level of dietary zinc for domestic birds is 1000 mg/kg (NAS [1980]). For the Least Bell's vireo (the most-sensitive receptor), the ecoPRG concentration in soil (254 mg/kg) would give rise to an estimated Tier-1 exposure dose of 109 mg/kg$_{BW}$–day and an estimated Tier-2 exposure dose of 172 mg/kg$_{BW}$–day, less than that maximum tolerable level."*

Reference cited:

NAS (National Academy of Sciences). 1980. *Mineral Tolerances of Domestic Animals*. National Academy Press; National Academy of Sciences, Washington, D.C.

**Comment 19: Appendix F1 Cost Estimate for the Site 1A-1 Soil Alternatives, Page F1-2:** For clarity and completeness, please list the assumed extent for the engineered soil cover in the list of assumptions.

**Response:** Appendix F1 has been revised to incorporate this comment.

**Comment 20: Appendix F1 Cost Estimates for the Site 1A-1 Soil Alternatives, Page F1-3:** Since chemical stabilization was determined to be infeasible at the site, please delete stabilization from this cost estimate.

**Response:** Please refer to the response to Comment 3

**Comment 21: Appendix F1 Cost Estimates for the Site 1A-1 Soil Alternatives, Page F1-3:** For clarity and completeness, please list the assumed depth and volume for the soil excavation alternative.

**Response:** The text has been revised accordingly.

**Comment 22: Table F1-3 Site 1A1 Alternative 1A-3: Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls Estimated Total Costs:** In this table the area for clearing and grubbing is 2.56 acres, but it is not clear how this area was determined. Since the extent of impacted soil is approximately 1.5 acres, please revise the FS to clarify how the capping area was calculated. Also, since the impacted area is described as approximately 66,700 square feet, it is not clear why

111,700 square feet of geogrid is required. Please clarify how the extent of geogrid was calculated.

**Response:** The area of the cap and extent of the geogrid was calculated based on the estimated area of waste fill soil and surface debris (approximately 66,700 square feet). An estimated length times width of the impacted area was determined then increased by 30% to allow for cap overlap to eliminate infiltration and to strengthen cap integrity. This text along with a calculation breakdown has been added to the revised document to clarify how the area of the cap and extent of the geogrid was calculated.

**Comment 23: Table F1-5 Site 1A-1 Excavation, Soil Pre-Treatment, Backfill, and off-Base Disposal Detailed Subcontractor Costs:** This table lists 35100 units of CA hazardous material and 3900 units of non-hazardous material to be disposed of; however, it is not clear what the units are. Furthermore, the FS estimates 9000 cubic yards (or 17,550 tons) or RCRA or CA hazardous material will be excavated. It appears that the 35100 units of CA hazardous material listed in Table F1-5 may be in error. Please review these numbers and correct as appropriate. Furthermore, since soil pretreatment will not be feasible at this site, please revise the cost estimate to take into account disposal of untreated soil.

**Response:** The units in question in Table F1-5 are tons of contaminated soil and also tons of backfill material. Table F1-5 has been revised to add these units under Task 5 and Task 7, respectively. With respect to the quantities of material to be handled at Site 1A-1, 17,550 tons of soil will be pretreated prior to disposal. However, there is a total of 39,000 tons of soil to be removed from this site (20,000 in situ cubic yards X 1.3 correction factor for excavated soil X 1.5 conversion from ex situ cubic yards to tons = 39,000 tons). After pretreatment, soil will be removed from the site as either California hazardous (35,100 tons) or non-hazardous (3,900 tons).

Additionally, soil pretreatment at this site is a feasible option. The non-feasible option that was ruled out for this site was solidification/stabilization for on-Base reuse in roadways and construction (please see response to Comment 3, for clarification).

**MINOR COMMENTS (SITE 1A-1)**

**Comment 24: Section 2.1.5 Human Health Risk Assessment, Page 2-5:** The cumulative RME risk to a hypothetical nonintrusive worker is given as 2 x 10E-4, and to an intrusive worker is 2 x 10E-6; however, it is not clear how the risk to an intrusive worker could be less than the risk to a nonintrusive worker. Please review these values.

**Response:** Risks and hazards were less for intrusive versus nonintrusive workers based on the input assumptions (primarily due to differences in the exposure frequencies and exposure durations) agreed upon in the HHRA Protocol Document (Parsons, 2003a) and RI Report (Parsons, 2004a). Refer to the attachments to Appendix I of the RI Report (Parsons, 2004a) titled, "Supporting Calculations for Human Health Risk Assessment" for detailed information on the algorithms, chemical-specific input parameters, and risk/hazard calculations for the nonintrusive and intrusive workers.

Text and tables have not been modified.

**Comment 25: Section 2.6.3.2 Compliance with ARARs, Page 2-30:** This paragraph states that because elevated levels of lead would remain at the site, post-closure care is required; however, it appears that all of the COCs would remain, including dioxins, antimony and zinc. Please revise this section to indicate that all the COCs would remain or clarify why lead drives the post-closure care requirements.

**Response:** The word "lead" has been replaced with "COCs" in this paragraph,

**SITE 1111**

**MAJOR COMMENTS (SITE 1111)**

**Comment 26:** Viable containment options were eliminated from consideration as groundwater remedies in this FS based on evidence which suggests that the plume is not migrating. However, wellhead treatment was retained for screening and, though not retained as a remedial alternative for the site, it is considered a contingency option if contamination reaches the production well after the selected alternative is implemented. It appears that a containment technology could also be retained as a contingency option if contaminants are found to migrate, and could be implemented long before contamination reaches the production well. It would be useful as a contingency measure to have the most cost-effective containment alternative evaluated in this FS. Please revise the FS to include preliminary screening of groundwater containment technologies in order to have the most viable containment alternative available as a contingency option.

**Response:** The FS concludes that a hydraulic barrier to contain the VOC plume at Site 1111 is technically feasible and implementable, but not practical because of the very low concentrations and lack of downgradient contaminant migration observed at the site.

**Comment 27:** A sentry well, at a designated downgradient point between the plume boundary and production well 10S/04W-07R02 is proposed under Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring; however, the well shown on Figure 4-7 is neither downgradient nor is it between the plume and production well 10S/04W-07R02. The location shown is a cross-gradient location. Please revise the location of the proposed sentry well to be between the plume and the production well in a downgradient location, as described.

**Response:** Figure 3-7 has been revised to correct the position of the proposed sentry well as described in the text.

**Comment 28:** The groundwater alternatives include Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring, which does not include source removal; and Alternatives 1111-G3 and 1111-G4, which do. However, since excavation is the only viable soil alternative (the other soil alternatives do not meet the threshold criteria), it appears the source removal will occur regardless of which groundwater alternative is selected. Therefore, it is misleading to include a groundwater alternative which does not include source removal. In order to better evaluate the relative merits of

the various groundwater alternatives, please revise the FS to include source removal as an assumption for all groundwater alternatives.

**Response:** For comparative purposes, it was considered appropriate to include an alternative that does not reflect removal of the source. Although selection of this remedy is not likely, the inclusion of this cost estimate provides justification for why source removal makes sense. However, the requested change has been incorporated into the document as described in the comment to allow the suggested comparison.

**Comment 29:** Alternative 1111-G4 is identical to Alternative 1111-G3 with the addition of bark mulch or compost included in the backfill of the excavation during source removal. The FS states that this addition will result in more rapid attainment of MCLs or background levels in groundwater; however, the estimated duration for Alternative 1111-G4 is three years for MCLs and five years for background levels, which is the same as the estimated duration for Alternative 1111G-3. Please revise the evaluation of this alternative to clarify that there is no apparent benefit for the additional cost. Furthermore, the FS should discuss that regulatory agency approvals will be necessary for any soil or water amendments to enhance remediation.

**Response:** Both Alternative 1111-G3 and Alternative 1111-G4 involve source removal. From 95 to 99 percent of the source is expected to be removed by excavation of the source area. Therefore, the addition of bark mulch or compost to the backfill of the excavation (Alternative 1111-G4) would only be effective on the remaining 5 to 1 percent of source that is not removed by the excavation. The estimated durations to achieve MCLs and background are 3.4 years, and 4.9 years for Alternative 1111-G3 and 2.6 years and 4.1 years for Alternative 1111-G4. Due to the uncertainties associated with these estimates, both alternatives were rounded in the FS to 3 years for MCLs and 5 years for background. The FS has been revised to incorporate the above fractional duration estimates for each alternative in order to show the benefits of Alternative 1111-G4 for the additional cost.

**Comment 30:** See the Site 1A-1 Major Comment 4 regarding including present value analysis in the cost estimates.

**Response:** Please see response to Comment 4.

**Comment 31** See the Site 1A-1 Major Comment 5 regarding the selection of remedial goals and COCs.

**Response:** Please see response to Comment 5.

**SPECIFIC COMMENTS (SITE 1111)**

**Comment 32: Section 4.1.2.3 Geology, Page 4-2:** This section describes the gravel backfill area from the previous removal activity and the burn area; however, some of the area described as gravel backfill (southeast of 1111B02) is within the burn area. Please clarify whether some of the area shown as the burn area on Figure 4-2 has already been excavated and backfilled with gravel. If not, please correct the description of the gravel backfill area.

**Response:** As discussed in the response to RWQCB Comment 41, the current description of the soil conditions in the FS will be revised as follows to provide a clearer picture of distribution of the gravel backfill and the burnt soil layer.

- Borings logs for 1111B01, 1111B02, and 1111B03, and 1111TP-1 and 1111TP-2 all show gravel backfill to depths of 4 to 5 feet bgs, although gravel was only encountered to a depth of 2 feet bgs in 1111B03. The limits of the gravel backfill encompass this area.

- An approximately 6-inch thick layer of burned wood and other debris was encountered below the gravel at a depth of approximately 5 feet in borings 1111TP-1 and 1111TP-2 and, similarly, there was black soil and evidence of burning in borings 1111B01 and 1111B02. The burn layer was underlain by silty sand. Boring 1111B03 showed trash and debris at this depth, but no evidence of burning. Boring 1111SB-04, indicated a possible burn layer at 5 feet bgs, but this boring is approximately 40 northeast of any other borings where burn material was encountered, and analytical results do not indicate the burn layer extends to this location (i.e., COCs are below USEPA Region 9 residential PRGs).

- In areas outside the gravel backfill and burn layer area, sand and silty sand was encountered in monitoring well locations from ground surface to a maximum depth of 22 feet bgs.

**Comment 33: Section 4.1.2.4 Hydrogeology, Page 4-3:** This section describes the depth at which groundwater was encountered, but not the thickness of the aquifer. Since the thickness of the aquifer, and the depth of the aquifer's lower confining layer, factor into the screening of groundwater alternatives, please revise the FS to provide this information. Furthermore, it is not clear is the Base production well described in this section is screened in the same aquifer. Please revise the FS to clarify the groundwater source for the Base production well.

**Response:** Regarding the downgradient Base production well, there are two points addressed below.

**Point 1: Provide the thickness of aquifer and the depth of the aquifer's lower confining layer.**

Borings drilled at part of the Site 1111 investigation did not extend below 22 feet; however, based on cross sections from the RI Report for Group A Sites, Draft Final (IT, 1993), which are based on nearby Base production wells and monitoring wells at Site 3, the thickness of the alluvial aquifer material is estimated to be a minimum of 80 to perhaps 150 feet, with the aquifer's lower confining layer being defined as igneous basement rock.

The basement rock was encountered at a depth of 120 feet in Base production well 10S/04W-07A02, which is approximately 2,100 feet north of Site 1111.

Base production well 10S/04W-07H02 and monitoring well 3W-35/AB are the closest "deep" wells to Site 1111. Well 10S/04W-07H02 is located approximately 600 north of Site 1111. Sedimentary bedrock was reportedly encountered at a

depth of approximately 80 feet bgs in this well with alluvial material from ground surface to a depth of 80 feet bgs. The total drilled depth was approximately 96 feet bgs, and the well was screened from approximately 63 to 93 feet bgs., across both alluvium and sedimentary bedrock.

Monitoring well 3W-35A/B is located 600 to the southwest of Site 1111 at nearby Site 3. This well was advanced to a total depth of approximately 90 feet and only encountered alluvial material, without encountering sedimentary bedrock or igneous basement rock. The well screen was placed between approximately 62 and 82 feet bgs in well 3W-35A/B.

A 5 to10 layer of silt occurs below a depth of 45 feet in wells 10S/04W-07H02 and 3W-35A/B; however this silt layer is considered part of the water-bearing aquifer materials, and the entire thickness of materials encountered in these two wells are considered to represent the aquifer thickness. Because these wells were terminated in either alluvial material or apparently water bearing sedimentary bedrock, the maximum aquifer thickness was not determined.

Base production well 10S/04W-07R02 is located approximately 1,800 feet southwest of Site 1111, and this well encountered alluvial material to the total drilled depth of approximately 140 feet, with a 9-foot thick layer of silt occurring between approximately 65 and 74 feet. The well is screened from approximately 100 to 140 feet bgs. The entire thickness of sediments encountered (~140 feet) while drilling this well can be considered the aquifer thickness. Because the well was terminated in alluvial material, the maximum aquifer thickness was not determined.

**Point 2: It is not clear if the Base production well 10S/04W-07R02 is screened in the same aquifer.**

The entire thickness of materials encountered in nearby deep Base production wells and monitoring wells is considered part of the aquifer, and therefore, Base production well 10S/04W-07R02 is believed to be screened within the same aquifer as the shallow wells at Site 1111. There are no known laterally continuous aquitards or aquicludes that would restrict the vertical migration of shallow groundwater occurring at Site 1111 to down-gradient Base Production well 10S/04W-07R02.

**Comment 34: Section 4.4.4 Removal, Page 4-12:** This section states that the vertical extent of contamination is limited to an average depth of six feet below the ground surface; however, it is not clear from the information presented in this FS that contamination does not extent deeper. The RI figures show that most samples were collected from no deeper than 6 feet, and that contaminants exceed RGs at this depth. Furthermore, a sample collected deeper than 6 feet, at 1111MW-03, exhibited dioxin concentrations in excess of the RG up to 15 feet deep. Please revise the FS to provide further justification for the assumption that the average depth of contamination is six feet.

**Response:** Additional explanation has been provided to justify the estimate of six feet for the excavation. The reasons for this include that the risk to human health or ecological receptors is based on COC concentrations within the upper five to six feet, and that the groundwater table is present at approximately six

feet. With regard to risk to groundwater, dioxins are highly immobile, there are no reported concentrations of dioxins in groundwater downgradient of the site, and the concentrations of dioxins reported below the water table are relatively low. Also, it should be noted that the boring in question was drilled through the most dioxin-contaminated portion of the site, which raises the possibility that low-level COCs may have been carried downward by drilling operations at that time. Note that if soils are excavated, RGs should be met in the confirmation samples, and it may be necessary to go below the water table to achieve that goal. For costing purposes however, six feet is considered appropriate because there are portions of the excavation that will likely not need to be six feet deep.

**Comment 35: Section 4.4.4 Removal, Page 4-12:** Groundwater is encountered at a depth of from four to nine feet bgs. It appears that the excavation may extend below the water table if all of the contaminated soil is to be removed, since contaminants exceeding RGs have been detected up to 15 feet deep. Please clarify if the excavation will extend to the bottom of the contaminated soil or to groundwater. If all contaminated soil will not be removed, the FS should be revised to evaluate the impact of the residual source area on groundwater quality.

**Response:** Please refer to response to Comment 34.

**Comment 36: Section 4.5.5 Disposal, Page 4-19:** This section refers to pretreatment of waste using stabilization prior to off-Base disposal. Please see the comments on Site 1A-1 regarding the on-Base TTU.

**Response:** Please refer to response to Comment 3.

**Comment 37: Section 4.6.2.3 Alternative 1111-S3: Soil Excavation, Backfill, and Off-Base Disposal, Page 4-23:** This section states that the remedial COCs for this site are metals and therefore confirmation samples would be analyzed for total metals and VOC concentrations; however, the COC list includes dioxins, SVOCs and pesticides. Please revise the FS to include confirmation sampling at this site for dioxins, SVOCs and pesticides, in addition to metals and VOCs.

**Response:** The text and Appendix F have been revised to ensure that all site COCs are included in the confirmation sampling.

**Comment 38: Section 4.6.3.5 Short-Term Effectiveness, Page 4-28:** The description of the soil excavation alternative states that the affected areas would be backfilled and allowed to revegetate; however, due the sensitive nature of the habitat, some sort of habitat restoration may be required. Furthermore, the cost estimate for this option includes revegetation of the site. Please revise this section to clarify that the habitat will be restored in affected areas following excavation.

**Response:** The suggested text has been added to this section.

**Comment 39: Human Health Risk Assessment, Ecological Risk Assessment:** See Site 1A-1 specific comments regarding Appendix D (Site 1A-1 Specific Comments 5-8, Sections D1, D2, D2.2, and D2.2.2)***[Comments 12 through 15 in this document]***; and Appendix E (Site 1A-1 Specific Comments 9-11, Section E3.2) ***[Comments 16 through***

***18 in this document]*** derivations of human health and ecological risk-based remedial goals.

**Response:** Please see responses to Comments 12 through 15 and 16 through 18.

**Comment 40: Appendix F3 Cost Estimates for the Site 1111 Soil Alternatives, Page F3-2:** Please revise this list of assumptions to include the assumed depth of excavation and whether any excavation below the water table is assumed. If excavation below the water table is assumed, please provide any assumptions regarding water handling.

**Response:** The assumed depth of excavation has been added to the list. The upcoming EE/CA for this site will include any refinements or addition to the proposed soil removal.

**MINOR COMMENTS (SITE 1111)**

**Comment 41: Section 4.1.4 Contaminant Fate and Transport, Page 4-5:** The FS states that 5 years would be required to achieve MCLs in groundwater and 3 years would be required to achieve background concentrations. These values appear to be backwards. Please review these estimated durations, or clarify whether background levels exceed MCLs at this site.

**Response:** The cited values in Section 3.1.4 were backwards and have been corrected.

**Comment 42: Section 4.1.5 Human Health Risk Assessment, Page 4-5:** The FS lists the cumulative RME risk to a nonintrusive worker as 1 x 10E-5 and to an intrusive worker as 6 x 10E-6. These values appear to be backwards. Please review these risk values.

**Response:** Please see response to Comment 24.

**Comment 43: Section 4.6.2.3 Alternative 1111-S3: Soil Excavation, Backfill, and Off-Base Disposal, Page 4-22:** There appear to be errors and inconsistencies in this section. For example, the excavation area is described as 800 by 600 feet, but the area shown on the figure appears to be no more than 80 by 100 feet; Figure 2-7 is referred to, but there is no Figure 2-7; the conversion factor from cubic yard to tons used in the cost estimate is 1.5, but a conversion factor of 2 appears to be used in this section. Please review these values.

**Response:** The text has been revised for consistency. The excavation area is 80 by 100 feet and the reference should have been to Figure 3-2. The factor of 2 represents the cumulative addition of "fluff" to account for the in situ to ex situ volume plus the conversion 1.5 tons per yard.

**Comment 44: Section 4.6.2.3 Alternative 1111-S3: Soil Excavation, Backfill, and Off-Base Disposal, Page 4-24:** The FS refers to existing storm water utilities at this site; however, it appears that the excavation area is in an undeveloped location. It is not

clear where the existing storm water utilities are which may be impacted by the excavation activities. Please revise the FS to describe or show these utilities on a figure.

**Response:** The text has been revised for consistency; existing storm water utilities are not present at this site.

**Comment 45: Section 4.6.3.2 Compliance with ARARs, Page 4-26:** This paragraph states that because elevated levels of lead would remain at the site, post-closure care is required; however, it appears that all of the COCs would remain, including dioxins, VOCs, SVOCs, antimony, arsenic, mercury and pesticides. Please revise this section to indicate that all the COCs would remain or clarify why lead drives the post-closure care requirements.

**Response:** Text in the "Alternative 1111-S2: Institutional Controls" paragraph of Section 3.6.3.2 has been modified to read, "Because elevated levels of COCs in excess of the proposed remediation cleanup goals would remain at the site, post-closure care would required. Alternative 1111-S2 partially meets this requirement ..."

**Comment 46: Section 4.12.3.1 Overall Protection of Human Health and the Environment, Alternative 1111-G4: Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3 Page 4-59:** This paragraph refers to contaminant mass at the edge of the pond. This phrase does not appear relevant Site 1111. Please review and revise as appropriate.

**Response:** The text has been revised to remove reference to the pond.

**12 AREA, SITE 13**

**MAJOR COMMENTS (12 AREA, SITE 13)**

**Comment 47:** The analysis of contaminant fate and transport at 12 Area, Site 13, presented in the FS, implies that the shallow plume is the source of contaminants in the deep aquifer, and that contaminants enter the deep aquifer at the perched/deep groundwater merging point. However, this model does not appear to account for the contaminant concentrations in the deep aquifer. For example, BTEX concentrations are slightly higher in wells downgradient of the perched/deep groundwater merging point. It appears the hydrology of the site is not completely understood. Furthermore, the FS indicates that monitoring wells do not fully penetrate the deep aquifer. Due to the highly heterogenous and laterally discontinuous sedimentary beds beneath the site, contaminants may migrate in a subsurface layer which is not intercepted by the existing deep wells. In order to justify the conclusion that contaminants are not migrating in the deep aquifer, a well or wells should be installed which penetrates the entire aquifer in a direction downgradient of the area of highest known contamination in the deep aquifer.

**Response:** The fate and transport analysis presented in the FS does not intend to imply that contaminants enter the deep aquifer only at the perched/deep groundwater merging point. As discussed in the FS, we recognize that VOC contamination in the perched groundwater is most likely impacting the deep aquifer through vertical pathways (i.e., the perched zone is discontinuous and "leaky"). Perched groundwater is contained primarily in heterogeneous and

discontinuous layers of sand, silty sand, and clayey sand, all of which contributes to the observed vertical migration. However, deep groundwater is present within more uniform, very dense, fine- to coarse-grained, saturated sands and silty sands, which is underlain by a continuous, low-permeability clay and silt layer that acts as an aquitard. Groundwater presence in the deep zone is more uniform and continuous than in the perched zone. Based on the observed conditions, the existing deep wells are more likely to intercept contaminant migration than is suggested in the comment. Placement of the screened intervals of the deeper wells is considered appropriate, given the very low concentrations present in the deeper zone. Drilling deeper, through the fine-grained, apparently continuous, aquitard is not considered appropriate or necessary.

**Comment 48:** Please see the comment for Site 1111 regarding evaluating containment alternatives for a contingency option in the event the plume is found to be migrating.

**Response:** The FS concludes that a hydraulic barrier to contain the VOC plume at 12 Area, Site 13 is technically feasible and implementable, but not practical because of the very low concentrations and lack of downgradient contaminant migration observed at the site.

**Comment 49:** See the Site 1A-1 Major Comment 4 regarding including present value analysis in the cost estimates.

**Response:** Please see response to Comment 4.

**Comment 50:** See the Site 1A-1 Major Comment 5 regarding the selection of remedial goals and COCs.

**Response:** Please see response to Comment 5.

**SPECIFIC COMMENTS (12 AREA, SITE 13)**

**Comment 51: Section 5.1.3 Nature and Extent of Contamination, Page 5-5:** The concentration of benzene in deep groundwater is provided, but the concentration of TCE is not. However, the FS indicates that there are low concentrations of TCE in the deep aquifer. For clarity and completeness, please revise this section to provide the highest concentration of TCE detected in the deep aquifer.

**Response:** TCE was detected in December 2001 in deep groundwater at very low concentrations, with the highest concentration detected at S13-MW17 at 0.5 µg/L. The text has been revised to include this information.

**Comment 52: Human Health Risk Assessment:** See Site 1A-1 comments regarding derivation of risk-based remedial goals presented in Appendix D (Site 1A-1 Specific Comments 5-8, Sections D1, D2, D2.2, and D2.2.2) ***[Comments 12 through 15 in this document]***.

**Response:** Please see responses to Comments 12 through 15.

## MINOR COMMENTS (12 AREA, SITE 13)

**Comment 53: Section 5.1.2.4 Hydrogeology, Page 5-4:** Groundwater elevations are reported to range from 314.32 to 235.47 feet above sea level in the perched aquifer, but elevations in the deep aquifer ranged from 274.74 to 293 feet above sea level. Therefore, the perched groundwater appears to have been lower than the deep groundwater at some point. Please clarify if deep groundwater occurs under confined conditions, or if this is an error.

> **Response:** There was a typographical error in this sentence, the elevation range should have read "....314.32 to 325.47 feet amsl...." and the text has been corrected.

**Comment 54: Section 5.4.4.2 Well Points, Page 5-15:** The discussion of applicability of well points for this site refers to 'scattered, widespread detections'; however, at 12 Area, Site 13 there are clearly defined plumes. This phrase does not appear to be relevant to this site. Please review this section for accuracy, and revise the conclusions as appropriate.

> **Response:** The cited text has been revised to reflect that this extraction technology was also not further considered because pump-and-treat of such low concentrations has been found to entail long-term O&M costs, for which there would be no measurable risk reduction in this case. "Widespread" in this context refers to several hundred feet, within which concentrations of benzene and TCE are generally below 10 µg/L.

***[The following text/comments were provided by Letitia Moore in a letter to Martin Hausladen, dated June 16, 2005 and received by the Navy on June 27, 2005.]***

Generally the correct potential ARARS seem to be initially identified, but then conclusions are drawn about feasibility that suggest that the ARARs should be ignored. The real issues surround the technical basis for those conclusions. I presume those technical issues are being worked on by the FFA Team. I don't know that I can add anything to the technical debate.

**SPECIFIC COMMENTS**

**Comment 55:** More stringent State hazardous waste requirements in California's RCRA authorized program are part of the federally authorized program and federally enforceable. Such requirements are therefore potential Federal ARARs. Broader in scope State requirements are not part of the federally authorized program, not federally enforceable and therefore potential State ARARs rather than Federal ARARs. Correct the language at p. A2-14.

> **Response:** The comment is correct. In section A2.2.3.2, the words "or more stringent" have been removed from the text to address this comment. The second sentence now reads, "When state regulations are broader in scope than their federal counterparts, they are considered potential state ARARs."

**Comment 56:** What is the basis of the determination that cleanup to background is "not technologically and economically feasible" for Sites 21, 1111 and 12 Area, Site 13? Is this a determination that the cleanup is "technically impracticable from an engineering perspective" and not cost effective, i.e. costs not proportional to overall effectiveness?

> **Response:** Active remediation to concentrations below MCLs is determined to not be economically feasible. In other words, it is not considered economically feasible to achieve cleanup to below risk-based criteria. Note, however, that the selected remedial alternatives could result in levels lower than risk-based levels and could even result in meeting background over time. However, it is has been determined that additional work to meet levels lower than risk-based levels is not economically feasible since risk levels will already be acceptable.

**Comment 57:** Couldn't capping and institutional controls for contaminated soil potentially generate hazardous waste through leaching and/or run-off? So concentration limits may be relevant and appropriate?

> **Response:** For the capping alternative at Site 1A-1, we have determined that concentration limits may be relevant and appropriate. Refer to the text on page A2-14, the section entitled "RCRA Hazardous Waste and Groundwater Protection Standards," paragraph 3, 5th sentence, which reads, "For other actions that do not generate waste such as the capping alternative for Site 1A-1, or institutional controls, the concentration limits may be potentially relevant and appropriate."

**Comment 58:** Is there technical agreement on the FFA Team on the classification of groundwater at the OU5 Sites?

**Response:** There is no disagreement on the classification of groundwater, but there is some ongoing discussion regarding what bearing, if any, Resolution 88-63 has on remedial decision-making. That is, if site groundwater does not meet the water quality criteria outlined in the resolution, that factor should at least be considered when deciding on the appropriate alternative for the site, or the acceptable timeframe for achieving the remedial goals. Ultimately, there will be technical agreement that the selected alternative will meet the requirements of each agency.

**Comment 59:** Page A2-6 - are we saying that the groundwater cleanup is not "technologically and economically achievable/feasible because it is not currently being used as groundwater? Where is that standard coming from?

**Response:** As noted in response to Comment 56, it is not considered economically feasible to achieve cleanup to below risk-based criteria. Refer to the text that has been added to the section entitled "RCRA Groundwater Protection Standards," page A2-6, 5th paragraph, as follows: "Further remediation beyond risk-based levels is determined not to be economically feasible. The cost for monitoring and other active remediation to reach below those levels is not determined to be economically feasible. However, it is recognized that background levels will most likely be met over time."

**Comment 60:** Is there technical agreement on the FFA Team on the RAOs and points of compliance for the groundwater action?

**Response:** As noted in response to RWQCB Comment 5, "The use of the term 'point of compliance,' will be removed from the document, and instead the text will reflect that site monitoring wells will be used to ensure that the plume is not migrating offsite." There is agreement on the RAOs, and the selected remedy will meet FFA Team requirements.

**Comment 61:** Are we taking the position that a requirement is only relevant and appropriate if there is "a threat to human health and the environment" from the remedial activity? Where is that standard from?

**Response:** We are not taking the position that a requirement is only relevant and appropriate if there is "a threat to human health and the environment" from the remedial activity. As noted in Section A1.1:

The criteria for determining relevance and appropriateness are listed in 40 CFR § 300.400(g)(2) and include the following:

- the purpose of the requirement and the purpose of the CERCLA action;
- the medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site;
- the substances regulated by the requirement and the substances found at the CERCLA site;
- the actions or activities regulated by the requirement and the response action contemplated at the CERCLA site;

- any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site;
- the type of place regulated and the type of place affected by the release or CERCLA action;
- the type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action; and
- any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resources at the CERCLA site.

**DRAFT OPERABLE UNIT 5 FEASIBILITY STUDY**
**FOR SITES 1A-1, 21, 1111, AND 12 AREA, SITE 13**
**MARINE CORPS BASE CAMP PENDLETON, CALIFORNIA**

**RESPONSE TO COMMENTS FROM**

**THE DEPARTMENT OF TOXIC SUBSTANCES CONTROL**
**(RECEIVED 5 APRIL 2005)**

***[As discussed during the FFA meeting held 24 May 2005, comments and responses relating to Site 21 have been removed from this document and will be addressed separately in a Technical Meeting and included in a separate report for Site 21. Section numbers in the responses to comments on Site 1111 and 12 Area, Site 13 reflect the section numbers of the draft final document. The remaining comments have been sequentially numbered to facilitate discussion.]***

**SPECIFIC COMMENTS**

**Comment 1: Section 1, Introduction:** Include acknowledgment in the document that Site 6A is part of OU 5; however, the site is not evaluated in the FS because the site was recommended for NFA based on the results of remedial investigation.

> **Response:** Section 1.0 and the executive summary have been revised to acknowledge that Site 6A is part of OU 5 but was not evaluated in the FS because it was recommended for NFA based on the results of the remedial investigation.

**Comment 2:** The report describes the detection limits of 0.5 micrograms per liter (µg/L) for volatile organic compounds (VOCs) as background value. The Navy may propose cleanup goals as the lowest detection limits; however, detection limits are not background levels. The statement is not consistent with detection limits for purposes of reporting (DLRs) for VOCs promulgated under California Code of Regulations (CCR), Title 22, Division 4, Chapter 15, Article 5.5, section 64445.1. Please delete statements throughout the report regarding background levels for VOCs because the DLRs for some VOCs are lower than 0.5 µg/L.

> **Response:** Section 1.5.2 of the FS report states that "*....although background levels of VOCs are essentially zero, a concentration of zero cannot be measured.*" This section also states that "*.... a value of 0.5 microgram per liter (µg/L) is considered the background (or detectable) level of VOCs <u>for purposes</u> of evaluating groundwater remedial alternatives.... rather than assuming a concentration of zero).* The value of 0.5 µg/L is not being proposed as a cleanup goal but rather as a reasonable assumption to simplify the evaluation of alternatives that cleanup to background for all VOCs. The text has been revised to clarify that background must be consistent with detection limits for purposes of reporting (DLRs) for VOCs promulgated under California Code of Regulations (CCR) Title 22, Division 4, Chapter 15, Article 5.5, and therefore, may be lower than 0.5 µg/L.

**Comment 3: Section 2.6.2.2, Alternative 1A1-2, Institutional Controls (ICs):** Please describe the mechanism that will be used to implement the ICs. The sites may

need to be legally surveyed or the Marine Corps needs to evaluate the use of permanent markers and submit the text of the ICs language that will be included in the Base Master Plan (BMP) or other mechanism for each site separately. The restriction language should be concise and clearly spell what the site can be used for and the specific conduct that is prohibited along with the reason for the restriction. In addition, please include revisions regarding Notification/Request for Concurrence whenever land use change is anticipated in order to allow sufficient time for regulatory review and amendment to remedy selection document. The ICs should include annual inspection of the remedy and submittal of annual reports to regulatory agencies. Also, CERCLA requires that a five year review be conducted at the sites to ensure long term protectiveness of the remedy. Thus, regulatory agencies may inspect the remedy annually and monitoring reports (annual & 5 year reports) must be subject to regulatory agencies approval (including inspections, annual, and 5-year reports of the ICs).

The ICs are considered a remedy in accordance with California Health and Safety Code Section 25316 and Section 25260. The Marine Corps needs to provide assurance that there are adequate checks and balances within the process to ensure adherence to the ICs as specified in the California Military Environmental Coordination Committee (CMECC) ICs protocol dated May 5, 1998. Please submit an Implementation Plan (IP) for the ICs for regulatory agencies review and concurrence. Otherwise, DTSC may seek other mechanisms such as Memorandum of Agreement (MOA) allowed under the CMECC protocol to ensure our participation in the process and the long-term protectiveness of the remedy. Also, please evaluate the applicability of Title 22, Section 67391.1(e) (2) which includes alternative approaches for land use controls where it is not feasible to record Land Use Controls. Please evaluate Comment #3 for all sites included in the FS.

**Response:** As stated in Section 2.6.2.2, implementation of ICs will be conducted according to Navy standard procedures presented in DON memo titled *Monitoring and Enforcement of Land Use Controls* (U.S. Navy, 2003). This document provides the specific items to be included in the ROD and RAP, including listing the parties responsible for enforcing the land use controls, and the CERCLA five-year reviews to assess the effectiveness of the remedy.

**DTSC Response to Comment 3:** DTSC comment #3 requested details implementation plan (IP) for institutional controls at the sites that require institutional controls. The response completely ignored the comment and referred to Navy Standard procedures for monitoring land use control.

Please submit the specific IP and title of individuals who will carry out procedures that will be followed. DTSC wants to ensure that there are adequate checks and balances within the process to ensure adherence to the institutional controls. If DTSC is not comfortable with the IP, we may not support remedies that entails ICs or we may require a Memorandum of Agreement to ensure our participation in the process.

Please revise the text of the Feasibility Study and provide the details of the IP. Also, please read comment #3 and address the remaining issues raised in the comment.

**Response:** The DTSC document that is cited in the comment (the CMECC protocol dated May 5, 1998) states that the description of the ICs should be included in the Remedial Action Workplan, the Remedial Action Plan, or the Record of Decision. Similarly, the DON memo titled "Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions (2003)," states that LUCs should be specified in the ROD and Remedial Action Work Plan.

It is understood that if ICs are to be part of remedy at any of the sites, DTSC needs to feel comfortable that the ICs will be enforced and tracked. In the case of the OU 5 sites, the ICs that may be a condition of the alternatives would require that site groundwater is not used for drinking water (that is, ensure that a new well is not installed and used for drinking water). There are steps that can be taken by the Base to ensure that the IC is workable, such as inclusion in the GIS system, but ultimately the exact details of the IC would be spelled out in an implementation plan (IP). At the FS stage, we are looking for concurrence from the FFA Team on the concept of the ICs, with the understanding that the implementation details will be included in the IP and reviewed by all FFA Team members before actual implementation.

As stated in Section 2.6.2.2, implementation of ICs will be conducted according to Navy standard procedures presented in DON memo titled Monitoring and Enforcement of Land Use Controls (U.S. Navy, 2003). This document provides the specific items to be included in the ROD or RAP, including listing the parties responsible for enforcing the land use controls, and the CERCLA five-year reviews to assess the effectiveness of the remedy. It is understood that the FFA Team will need to thoroughly review and agree to the details of IC implementation, including specific restriction language, what system will be used to keep the ICs, how they will be triggered, the people responsible for tracking the ICs, and Base procedure language that specifies that land use changes need to be approved by knowledgeable personnel, among many other detailed requirements. It is proposed that all these detailed implementation procedures be contained in a Land Use Control (LUC) implementation plan (LUCIP), which will likely be attached to the ROD. The IP will be subject to review and discussion by the FFA Team. Based on the direction provided in these memos, it is not appropriate to prepare the IP for LUCs as part of the FS.

Selected text is re-printed below from the DON memo titled "Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions (2003). Please also refer to the memo in its entirety for full discussion of LUC implementation.

> *"Records of Decision should document the remedy selection process and remedy decision in accordance with CERCLA and the NCP, as well as applicable and appropriate guidance, regulations, standards, criteria, and policy. With regard to LUCs, the ROD should describe the LUC objectives; explain why and for what purpose the LUCs are necessary, where they will be necessary, and the entities responsible for implementing, monitoring, reporting on and enforcing the LUCs. The ROD will refer to the RD or RAWP for implementation actions."*

The following additional text is taken from the DON LUC memo regarding specific measures that will be followed in implementing LUCs:

> *"EPA and DON agree that the most efficient framework for specifying, implementing, monitoring, reporting on and enforcing LUCs is:*
>
> - *a standard FFA for NPL sites,*
> - *a clear, concise RoD with LUC objectives, and*
> - *a RD or RAWP with LUC implementation actions*
>
> *Relative to land use controls and institutional controls, the ROD shall:*
>
> - *Describe the risk(s) necessitating the remedy including LUCs;*
> - *Document risk exposure assumptions and reasonably anticipated land uses;*
> - *Generally describe the LUC, the logic for its selection and any related deed restrictions/notifications;*
> - *State the LUC performance objectives. (See attachment (2) for examples of LUC performance objectives);*
> - *List the parties responsible for implementing, monitoring, reporting on, and enforcement of the LUC;*
> - *Provide a description of the area/property covered by the LUC (should include a map);*
> - *Provide the expected duration of the LUCs; and*
> - *Refer to the RD or RAWP for LUC implementation actions, since these details may need to be adjusted periodically based on site conditions and other factors. (See attachment (2) for examples of LUC implementation actions)."*
>
> *Regarding the Remedial Design (RD) or Remedial Action Work Plan (RAWP):*
>
> - *The RD or RAWP will be provided as a primary document in accordance with the FFA.*
> - *The RD or RAWP will describe short and long-term implementation actions and responsibilities for the actions in order to ensure long-term viability of the remedy which may include both LUCs (e.g., institutional controls) and an*

*engineered portion (e.g., landfill caps, treatment systems) of the remedy. The term "implementation actions" includes all actions to implement, operate, maintain, and enforce the remedy. Depending on the LUC and site conditions, these actions can include:*

- *Conducting CERCLA five-year remedy reviews for the engineered remedies and/or LUCs.*
- *Conducting periodic monitoring or visual inspections of LUCs; frequency to be determined by site-specific conditions.*
- *Reporting inspection results.*
- *Notifying regulators prior to any changes in the risk, remedy or land use including any LUC failures with proposed corrective action.*
- *Including a map of the site where LUCs are to be implemented."*

Per Theresa Morley's Discussion with Tayseer Mahmoud on 26 September 2005, the following text will be included in the descriptions of institutional controls for the alternatives in the OU 5 FS:

*"If institutional controls are selected to be all or part of the remedy for the OU 5 sites, such controls will be implemented by MCB Camp Pendleton as part of the site approval process. Site approval is required for all projects at the Base involving construction, acquisition, or modification. Once site approval is requested, MCB Camp Pendleton Environmental Security must be consulted for environmental approvals, including for NEPA determination if applicable. The form that is used to initiate the site approval process is called the "Preliminary Environmental Data Sheet." Currently Mark Bonsavage is the primary point of contact for projects potentially affecting IR sites. If Mark vacated the position, whoever assumed the roll of IRP Manager would review the site approvals.*

*The role of Environmental Security in the site approval process includes maintaining a GIS system for environmental constraints at the Base, including wetlands, sensitive species, and IR sites. If a planned activity requires environmental review or falls within an area specified on the Environmental Operations map, Environmental Security gets involved to review the proposed actions and make recommendations."*

Please note that the Base Master Plan is not the appropriate vehicle for documenting IR sites or land use controls; instead, it is a document that specifies uses of the Base, such as cantonment areas and ranges. It does not provide the detailed controls on specific sites. Activities that could encounter contamination are covered in the environmental review of site approvals (contained in Base Order 11100.4B and Base Order 5090.2). Environmental Security sign-off is

required to allow projects at the Base involving construction, acquisition, or modification.

**Comment 4: Table 2-1 and Table 4-1 Proposed Remediation Goals:** Please reference the PRGs date of publication and specify if the PRGs are for residential or industrial.

**Response:** The proposed RGs were derived in Appendix D and Tables 2-1 and 3-1 have been revised for clarity.

**Comment 5: Table 3-2 and Table 5-2 Institutional Controls and Long-Term Monitoring:** The proposed monitoring frequency every 3 years for year 6 to year 30 and every 6 years thereafter may not be enough to support data gathering for the CERCLA 5-year review report.

**Response:** Table 3-2 and monitoring frequency will be addressed in a separate document for Site 21.

Both Table 4-1 for Institutional Controls and Long-Term Monitoring and Table 4-2 for Monitored Natural Attenuation show a monitoring frequency that would provide 7 sampling events in the first five years and 2 to 3 sampling events in the next five years. This should be adequate to evaluate the effectiveness of the selected remedy. The text in Section 4.6.2.2 has been revised to include that the monitoring network and sampling frequency would be continually reevaluated and revised as needed in response to plume changes and to determine if additional data would be needed to support the CERCLA 5-year review.

**Comment 6: Table 5-3, 12 Area, Site 13 Summary of Detailed Analysis of Alternatives:** The human health evaluation should include land restrictions on deep basement excavation for Alternative 12A-2.

**Response:** The proposed remedial goals (RG) and potential land use restrictions for the remedial alternatives presented in the FS were based on the results of the risk assessment presented in the RI report (Parsons, 2004a). These results were summarized in Section 4.1.5 of the FS. Future domestic use of groundwater (e.g., drinking water) and volatilization of chemicals of potential concern (COPCs) from groundwater into a future building were the only two potentially completed exposure pathways (refer to Section I6.1.2 of the RI [Parsons, 2004a]). As discussed in Section I6.3 of the risk assessment (Parsons, 2004a) and summarized in the FS, risk and hazard estimates for hypothetical domestic groundwater users exceeded USEPA's (1991b) point of departure target risk level of $1 \times 10^{-6}$ and target hazard index (HI) of one. However, the results of a conservative screening-level risk assessment indicated that adverse health effects associated with groundwater-to-indoor air volatilization and inhalation by future indoor workers are not expected (refer to Appendix J of the RI [Parsons, 2004a]). This evaluation was based on a hypothetical slab-on-grade structure. A supplemental evaluation indicated the risks do not change when reported to one significant figure at $2 \times 10^{-6}$ ($1.7 \times 10^{-6}$ is listed in Table J-1 and it would be approximately $2.3 \times 10^{-6}$ with a basement). Therefore, this evaluation indicates that restrictions on deep excavations (e.g.,

construction of a building with a basement) are not necessary from the perspective of potential future vapor impacts from VOCs in groundwater.

Text has not been modified.

**Comment 7: Table F1-3, Site 1A-1, Alternative 1A-3; Capping and Institutional Controls:** Add the cost of institutional controls for this alternative.

**Response:** The IC capital cost of $75,000 has been added to Alternative 1A1-3. The IC O&M cost for Alternative 1A1-3 is already built into the O&M costs for this alternative and therefore has not been added.

**Comment 8: Table F1-4, Site 1A-1 Excavation, Soil Pre-treatment, Backfill, and Off-Base Disposal, Cost Estimate:** Revise the foot note to include testing contaminated soil for total metal analysis. A total metals analysis is first performed to determine if a sample is hazardous by exceeding the corresponding Total Threshold Limit Concentration (TTLC) listed in Table II, Title 22, CCR. If the concentrations are above the TTLC the soil is considered a California hazardous waste. If the value is less than TTLC but greater than 10 times the corresponding Soluble Threshold Limit Concentration (STLC) value, a Waste Extraction Test (WET) will be performed. If the concentration of a substance in the (WET) extract is greater than the corresponding STLC, then the waste is a California hazardous. If a sample contains concentrations greater than 10 times the STLC, a RCRA determination is required by conducting a Toxicity Characteristic Leaching Procedure (TCLP) test. The waste is considered a RCRA hazardous waste if the analysis results exceed the TCLP value.

**Response:** Table F1-4 footnote has been revised to indicate testing contaminated soil for metal analysis. Note that total metal analyses are included in the proposed analytical program for Alternative 1A1-4 as shown in Table F1-5.

**Comment 9: Table A4-1, Potential Federal Action-Specific ARARs:** The Point of Compliance (POC) ARAR for Site 21 does not appear in the ARARs table; however, the POC is evaluated for Site 21 on page A2-6 of Appendix A. The POC ARAR will need to be deleted if the California Regional Water Quality Control Board does not approve the proposed remediation goals within the plume or at the POC.

**Table A4-2, Potential State Action-Specific ARARs for Soil and Groundwater:** Please provide an evaluation for land use controls remedy and restrictions on groundwater uses. The State ARARs submitted on the OU 4 FS may be used for the evaluation.

**Response:** As previously noted, Site 21 will not be included in the OU 5 Draft Final FS because the FFA Team plans to decide if specific additional data is needed to complete the Site 21 FS. For Site 21, DON and the FFA Team will ultimately reach agreement on remedial goals for the site during the time needed to perform additional technical data gathering. Please refer to Response to RWQCB Comment 5.

Table A4-2 has been revised to include an evaluation of land use controls remedies and restrictions on groundwater uses.

For additional comments on the Human Health and Ecological Risk Assessment, please see the enclosed comments from DTSC's Toxicologist, Dr. Riz A. Sarmiento, and Ms. Vicki Lake from the California Department of Fish and Game.

***[The following text/comments were provided by Riz A. Sarmiento, Ph.D. in a letter to Tayseer Mahmoud, dated March 18, 2005.]***

## DOCUMENT REVIEWED

The Human and Ecological Risk Division (HERD) reviewed the Draft Feasibility Study for Operable Unit (OU) 5, with the primary focus on the development of human health risk-based preliminary remediation goals (PRGs). The document was prepared by Parsons, located in Pasadena, California. The document was dated January 24, 2005.

## SCOPE OF REVIEW

These comments from HERD are primarily limited to its review of the sections in the document that pertain to the human health risk assessment. We assume that regional personnel have evaluated the evaluation of remedial alternatives and the costs associated with the different alternatives. Any future changes or additions to the document should be clearly identified.

## BACKGROUND

This document addresses (a) Site 1A-1 – Refuse Disposal Area adjacent to Site 1A, (b) Site 21 – Former Fuel Dock Facility, (c) Site 1111 – Burn Ash and refuse Disposal Area, and (d) 12 Area, Site 13 – Former Mess Hall and UST. This document discusses four proposed remedial alternatives for each site, namely, (1) no action, (2) institutional controls, (3) capping with an engineered soil cover, along with cap monitoring/maintenance and institutional controls, and (4) soil excavation, backfill, pretreatment, and off-base disposal. Remedial goals were developed to evaluate the remedial alternatives for the OU 5 sites with soil contamination.

## GENERAL COMMENTS

***[The following general comments have been sequentially numbered to facilitate discussion.]***

**Comment 10:** HERD's comments on the methodology for evaluating lead in the soil should be addressed in all the sites where lead was a chemical of potential concern. The document consistently applied the level of 3,500 mg/kg as the point of comparison for determining whether or not lead should be remediated. As indicated in the following specific comments, either the Region 9 PRG for lead or the USEPA Adult Lead Model should be used to evaluate lead.

> **Response:** Refer to the response to Comment 12, below.
>
> **DTSC Response to Comment 10:** HERD's comments were addressed adequately. Any reference to an occupational soil preliminary remediation goal (PRG) of 3,500 will be deleted in the revised FS. HERD recognizes that this change does not affect the remedial goal for lead because the proposed remedial goal is based on an ecological endpoint.
>
> **Response:** Comment noted; no further response necessary.

**Comment 11:** For future submittals, HERD recommends that the methodology for calculating the remedial goals be more streamlined. The Tables in Appendix D currently show a PRG calculated for each exposure pathway based on a target exposure-specific risk of 1E-06. These three different PRGs are then readjusted to calculate a combined PRG that presumably results in a cumulative target risk of 1E-06. A more efficient methodology is to back-calculate a PRG based on a cumulative target risk of 1E-06 by using the spreadsheet that was used to calculate the predicted risk estimate (forward calculations). Through this process, the estimated risks associated with each exposure pathway to the back-calculated or developed PRG are already evident. In addition to providing a more expedited review process, this approach reduces the number of steps and the possibility of calculation errors. Unless one of the alternatives in the feasibility study is to mitigate potential exposures through a single pathway, it is irrelevant to present PRGs for each pathway. This recommended methodology is seemingly similar to the methodology presented for deriving the ecological remedial goals (Section E2.4). Other specific comments are listed below.

> **Response:** The "ratio approach" used to calculate preliminary remedial goals (RGs) as described in Appendix D of the Draft FS is a simple, efficient method which ensures that the many input assumptions agreed upon and used in the RI (Parsons, 2004a) are incorporated into the preliminary RG calculations thereby minimizing the potential for input and calculation errors. The method used to combine route-specific preliminary RGs is consistent with the method used by USEPA Region IX (2004) in the development of their PRG table. Although the remedial alternatives are not necessarily designed to mitigate potential exposures through a single exposure pathway, route-specific preliminary RGs provide additional information and reviewers often request information on the primary exposure pathway of concern driving a particular remedial goal. However, HERD recommendations provided in this comment are acknowledged and will be considered for future submittals.
>
> **DTSC Response to Comment 11:** HERD does not agree that the "ratio approach", as it is applied in this document for calculating PRGs, is more efficient than the methodology that HERD recommended. At this point, the applied methodology will be deemed acceptable because these academic differences do not affect the proposed PRGs. HERD strongly suggests, however, that the recommended approach be applied in future submittals.
>
> **Response:** Comment noted; no further response necessary.

**SPECIFIC COMMENTS**

**Comment 12: Executive Summary, page iv:** Instead of using 3,500 mg/kg of lead for the occupational soil PRG, please use the USEPA Adult Lead Model or use the California EPA -modified PRG of 150 mg/kg (residential) and EPA Region 9 PRG of 800 mg/kg (industrial). Download the Adult Lead Model and User's Guidance from http://www.epa.gov/superfund/programs/lead/products.htm. The Technical Review WorkGroup of USEPA re-analyzed data from NHANES and found that the correct geometric standard deviation for adult females in the western U.S. is 2.11. The DTSC LEADSPREAD model has used the same geometric standard deviation for adults and children, 1.60, which accounts for an enormous difference. See http://www.epa.gov/superfund/programs/lead/products/nhanes.pdf.

**Response:** Although it is true that the re-analysis of the NHANES data (after combining Phase 1 and 2 data) indicated an increase in the geometric standard deviation (GSD) of the background blood lead concentration ($PbB_{adult,0}$) from 1.60 to 2.11, the authors of the re-analysis (USEPA, 2002) state that, "Decreases in estimates of GM PbBs *[geometric mean background blood lead concentrations]* observed between Phases 1 and 2 are offset by increases in the GSD *[geometric standard deviation]*. The net effect is that the ranges of Preliminary Remediation Goals (PRGs) calculated using the ALM *[adult lead model]* do not differ appreciably between the two phases."

As stated in the comment, LEADSPREAD7 is sensitive to the background blood lead GSD input parameter. However, simply changing GSD in LEADSPREAD7 without accounting for the corresponding decrease observed in the geometric mean background blood lead ($PbB_{adult,0}$) is not technically appropriate, particularly since as pointed out by USEPA in their re-analysis (2002), the net effect is that the range of PRGs do not differ appreciably. Text throughout the FS has been edited to: 1) delete any reference to the occupational-soil PRG of 3,500 derived using the Cal/EPA LEADSPREAD blood-lead model; 2) continue referencing the default industrial soil PRG range derived using USEPA's Adult Lead Model (1996b); 3) update the USEPA Adult Lead Model (1996b) default industrial soil PRG range of 700 to 1,500 mg/kg to 780 to 1,200 mg/kg based on USEPA's re-analysis (2002) and reported in the finalized Adult Lead Model technical guidance (USEPA, 2003); and 4) acknowledge that the lower end (780 mg/kg) of this updated range is consistent with USEPA Region 9's industrial soil PRG of 800 mg/kg (2004). Note that these edits do not affect the remedial goal at sites where lead was identified as a chemical of concern (COC) since the proposed remedial goal is based on an ecological endpoint. There is no effect on the volume of impacted soils.

References cited above:

USEPA. 2002. Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III). OSWER #9285.7-52. March.

USEPA. 2003. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. EPA-540-R-03-001. FINAL. January.

**DTSC Response to Comment 12:** HERD's comments were addressed adequately. Any reference to an occupational soil preliminary remediation goal (PRG) of 3,500 will be deleted in the revised FS. HERD recognizes that this change does not affect the remedial goal for lead because the proposed remedial goal is based on an ecological endpoint.

**Response:** Comment noted; no further response necessary.

**Comment 13: Section 2.1.5, 3rd paragraph, page 2-5:** See specific comment 1.

**Response:** Please see response to Comment 12.

**Comment 14: Table 2-1, Site 1A-1 Proposed Remediation Goals:** Please explain the source of the ERA Preliminary Remediation Goal (PRG) of 44 mg/kg for 2,3,7,8-TCDD by clarifying some of the information presented in Table 2-1. The first column shows 2,3,7,8-TCDD TEQ for birds or mammals but the scenario-specific soil concentrations lists values for other types of receptors, e.g., terrestrial vegetation, invertebrates, and mammals. In addition, please explain "No-Effect" versus "Effect". The ecological criteria are typically "No Observed Adverse Effect Level (NOAEL)" or "No Effect Level (NOEL)."

If, as stated in Table 2-1, the effect-based ERA PRG of 44 mg/kg is supposed to be the lowest of the ecological PRGs for any wildlife, then this is inconsistent with the discussion in Appendix E, Section E2.4 that states that the effect-based TRV indicates an upper-bound limit above which remediation might be unnecessary. Please explain why the no-effect-based TRV of 4.4 mg/kg was not selected as the ERA PRG. The same question applies for lead and zinc.

**Response:** The derivation of the ERA PRGs is described in Appendix E. As indicated in footnote "c," the ERA PRG values presented in Table 2-1 are the lowest of the ERA PRGs for any of the wildlife receptors based on an effect-based TRV. The indicated ERA PRG for the dioxins and furans is 44 nanograms 2,3,7,8-TCDD TEQ (for mammals) per kilogram soil (not milligrams per kilogram, as indicated in the comment), and was derived for the deer mouse; see the summary presented in Table 3-1 of Appendix E. The second column of Table 2-1 indicates a maximum 2,3,7,8-TCDD TEQ concentration (for humans) of 2700 ng/kg, as derived in Appendix I of the RI (the human-health risk assessment). Table 2-1 has been revised to indicate that the maximum concentration is a TEQ concentration for humans (referencing Appendix I and that the ERA PRG is a TEQ concentration for mammalian wildlife (referencing Appendix E).

It is unclear what is meant in the comment by "...the scenario-specific soil concentrations lists values for other types of receptors, e.g., terrestrial vegetation, invertebrates, and mammals" with respect to the referenced table, Table 2-1. Table 3-1 of Appendix E provides some ecological benchmark (PRG) values for plants and soil invertebrates for inorganic COCs. However, there are no benchmarks for plants or invertebrates for exposure-point concentrations that are expressed as TEQ concentrations for birds or mammals; hence, Table 3-1 of Appendix E indicates "no benchmark" for the plant and invertebrate receptors.

TRVs for ecological risk assessment are derived values that are not necessarily actual NOAEL or NOEL doses. That is, depending on the available data, a specific experimental dose might be modified through the use of uncertainty factors to produce a value assumed, but untested, to be equivalent to a NOAEL or NOEL dose. Use of the phrase "no-effect" is thought to be sufficiently informative to a reader to convey that the indicated value (e.g., a TRV or a hazard quotient [HQ]) is based on an absence of effect.

Use of the modifier "effect" conveys the information for a contrasting endpoint, that is, one associated with eliciting a toxicological response. TRVs can be derived based on Lowest Observed Adverse Effect Levels (LOAELs) or Lowest Observed Effect Levels (LOELs). However, as the reviewer is aware, the DTSC

requires the use of the Navy/USEPA Region 9 BTAG TRVs in assessing ecological risk for mammals and birds, and while the Low TRV values are derived as no-effect levels, the High TRV values are not lowest observed adverse effect levels. Describing these as "effect TRVs" or "effect HQs" is thought to be sufficiently descriptive and inclusive of TRVs that may, or may not, be based on the lowest effect level.

The comment misquotes the text. Section E2.4 of Appendix E states *"[t]he PRG derived using an effect-based TRV would indicate an upper-bound limit above which further remediation might be necessary, if the exposure-point concentration for the area were greater than the PRG value."*

The effect-based ERA PRG of 44 ng/kg is the lowest of the effect-based PRGs for the wildlife receptors. Referring to that value as the upper-bound limit was intended to mean that the value is the upper limit of a range of values bounded on the lower end by the no-effect PRG values. The no-effect PRGs for the small mammals (Pacific pocket mouse, deer mouse, and southern grasshopper mouse) range from 4.4 to 190 ng/kg and the effect-based PRGs range from 44 to 1900 ng/kg. (PRGs for the coyote are not mentioned here, because the Area-Use Factor for this widely ranging animal results in very high PRG values.) The 44 ng/kg value represents an exposure concentration above-which adverse effects might be expected (in a population of deer mice), that is, it is a threshold concentration for the onset of adverse effects.

As indicated in the Appendix E text, the rationale for selecting 44 ng/kg as the PRG for dioxins and furans is that if the maximum residual concentration is at or below the ecoPRG, then the exposure for a population of mobile receptors within that area would never be at concentrations greater than the PRG and the exposure-point concentration (e.g., the 95%UCL) would always be within an acceptable range of concentrations that would not result in effect-based HQ values greater than one.

**DTSC Response to Comment 14:**

**a)** HERD appreciates the clarification on the units, i.e., HERD's erroneous comment that the ERA PRG for the dioxins and furans is 44 milligrams per kilogram, rather than nanograms per kilogram.

**Response:** Comment noted; no further response necessary.

**b)** Not having reviewed the human health risk assessment in Appendix I of the RI, the basis for the human health risk-based PRG of 2700 ng/kg of TEQ concentration of dioxins is unclear. The residential soil PRG for 2,3,7,8-TCDD is 3.9E-06 mg/kg or 3.9 ng/kg. The ratio of 2700:3.9 is 692. If the residential soil PRG of 3.9 ng/kg is based on a target cancer risk of 1E-06, then the proposed PRG for 2,3,7,8-TCDD could result in a cancer risk of 6.92E-04. Please include a brief discussion on the basis for the proposed human health risk-based TEQ concentration for clarification.

**Response:** The HERD comment above, "...the human health risk-based PRG of 2700 ng/kg of TEQ concentrations of dioxins...." incorrectly reflects the

proposed preliminary remedial goal for 2,3,7,8-TCDD TEQ. Please note that: 1) the proposed 2,3,7,8-TCDD TEQ human-based remediation goal listed in Table 2-1 of the FS is 17 ng/kg (refer to the last column), not 2,700 ng/kg and was based on an industrial land use scenario (refer to Appendix D of the FS for further details); 2) the potential risk to a nonintrusive worker from 2,3,7,8-TCDD TEQ estimated in the risk assessment of the RI was 2E-04 (refer to Table 2-15 and Section 2.5 of the RI and Section 2.1.5 of the FS). Potential risks to a future resident at Site 1A-1 were not estimated as part of the baseline risk assessment for reasons discussed in the RI and summarized in the FS; and 3) as stated in Section D2 (Appendix D) of the FS, "Preliminary remediation goals (RGs) were also calculated for an unrestricted land use (Table D-2). Note that residential use of the site is not reasonably expected in the future, and therefore unrestricted land use is not a mandatory goal of cleanup for this site. However, the RGs that would achieve a residential exposure scenario are provided in this document because it is likely that they would be met if waste soils are removed as outlined in the remedial alternatives." An unrestricted land use PRG of 3.9 ng/kg for 2,3,7,8-TCDD TEQ (based on USEPA toxicity data) is listed in Table D-2 of the FS, which is consistent with the "residential soil PRG" mentioned in the comment.

**c)** HERD's comment stemmed from a lack of clarification on the term "scenario-specific soil concentrations" that was used in Table E3-1. It seems that the Navy's consultant is equally unclear on the meaning of this term. HERD is presuming that the Pacific Pocket Mouse, Deer Mouse, Southern Grasshopper Mouse, and Gray Fox are site-specific ecological receptors that were used to cull different ecological toxicity reference values (TRVs). If this is the case, HERD recommends that the term "scenario-specific" in Table E3-1 be changed to "Receptor-specific", thus, making it consistent with the title of the Table.

**Response:** With respect to this specific comment "c," HERD appears to use "PRG" and "TRV" interchangeably, and incorrectly. See, for example, the third sentence of the third paragraph of HERD's second comment. The following points provide further clarification concerning Table E3-1:

i. The Pacific pocket mouse, deer mouse, Southern grasshopper mouse, and gray fox are site-specific receptors, in addition to terrestrial vegetation, soil invertebrates and microbial processes, and the four bird species.

ii. The OU 5 Remedial Investigation provided the derivation of no-effect-based and effect-based TRVs for mammals (and birds). The TRVs are chemical-specific values for a specific group of receptors; the TRVs are not receptor-specific values.

iii. The title of Table E3-1 refers to "Receptor-specific Ecological Preliminary Remediation Goals" (receptor-specific ERA PRGs). Receptor-specific ERA PRGs are derived from receptor-specific exposure-parameter values and chemical-specific TRVs.

iv. As defined in footnote "d" of Table E3-1, "scenario-specific" refers to the different scenario features, that is, the AUF adjustment (which was not used in the Screening-Level ERA) and whether the PRG was derived using

receptor-specific exposure information and a no-effect TRV, or was derived using receptor-specific exposure information and an effect-based TRV.

v. The body of Table E3-1 presents receptor-specific ERA PRGs grouped into scenarios: only "no-effect" scenarios are presented for terrestrial vegetation and for soil invertebrates and microbial processes, while "no-effect" and "effect" scenarios are presented for the each of the mammalian and avian receptors.

The above information should clarify any lingering issues raised in DTSC's comment #14.

**Comment 15: Section 4.1.5, page 4-6:** The lead concentrations in the mixed soil samples ranged from 0.7 to 19,000 mg/kg with a standard deviation of 1,700. Please discuss how the 95 percent UCL of 96 mg/kg was derived. Considering the range of detected concentrations, please clarify the distribution of the data and explain the methodology for calculating the 95% UCL.

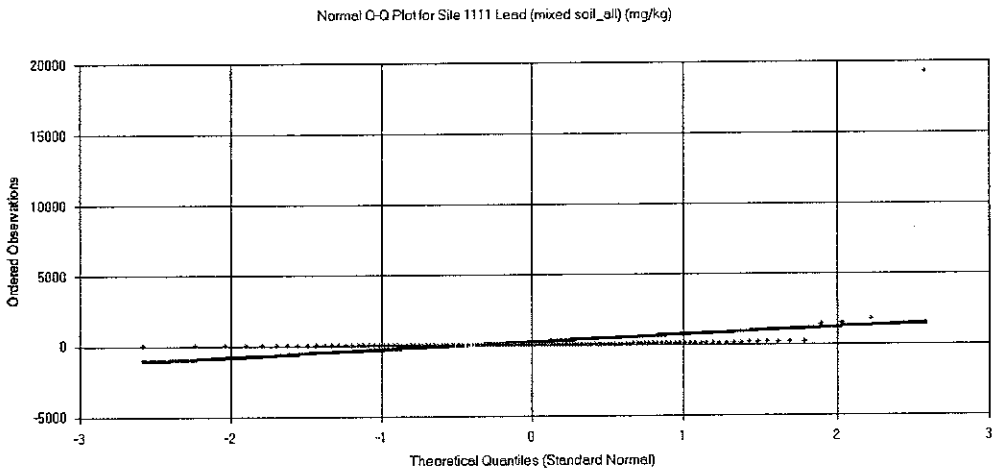
The site concentration of lead should be compared to either the industrial or residential soil PRGs established by EPA Region 9 (EPA, 2004) to the lead level developed by using the EPA Adult Lead Model (EPA, 2003).

**Response:** The surface and mixed soil 95% UCLs listed in Table I-14 of the RI report (Parsons, 2004a) were inadvertently misrepresented in the referenced text. The text has been corrected to read, "The 95-percent UCL surface (0 to 1.5 feet bgs) and mixed (0 to 10 feet bgs) soil exposure point concentrations of 110 and 380 mg/kg, respectively, are within the USEPA Adult Lead Model default industrial soil PRG range of 780 to 1,200 mg/kg based on USEPA's re-analysis (2002) and reported in the finalized Adult Lead Model technical guidance (USEPA, 2003). USEPA Region 9 conservatively used the lower end of this range when selecting an industrial soil screening PRG of 800 mg/kg (2004). Therefore, the lead 95-percent UCL in the mixed soil interval was 380 mg/kg, with concentrations ranging from 0.7 to 19,000 mg/kg.

As discussed in Section I1.2.1.1 of the RI Report (Parsons, 2004a), the mixed soil 95-percent UCL of 380 mg/kg was calculated per the methods described in Appendix C of the Human Health Risk Assessment (HHRA) Protocol Document (Parsons, 2003a). The bootstrap method (Efron, 1981), a nonparametric method recommended by USEPA (1997b) for censored data, was used to calculate 95 percent UCLs on the arithmetic means. The details are not repeated here.

As shown in the following Q-Q probability plot of lead concentrations in Site 1111 mixed (0-10 feet bgs) soils, the maximum detected concentration of 19,000 mg/kg (1111MW-3) was an extreme outlier. Based on an evaluation of the spatial distribution of detected lead, this sample is likely representative of a very small volume of soil. The next highest concentration was 1,760 mg/kg (also detected at 1111MW-3). Removing the maximum detected concentration of 19,000 mg/kg from the dataset results in a 95-percent UCL of 81 mg/kg using the methods described in the HHRA Protocol Document (Parsons, 2003a).

Note that location 1111MW-3 lies within the area at Site 1111 with soils that have visual evidence of contamination, other contaminant concentrations above industrial PRGs, and likely will regulate remedial action per Section 3.1.3.1 of the FS and as shown on Figure 5-11 of Appendix B. As discussed in Section 3, one of the soil remedial action objectives is to address potential exposure to human and ecological receptors within this impacted area.




References cited above:

USEPA. 2003. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. EPA-540-R-03-001. FINAL. January.

**DTSC Response to Comment 15:** This comment was addressed adequately.

**Response:** Comment noted; no further response necessary.

**Comment 16: Table 4-1:** Please refer to specific comment #3. The same comment applies on ERA PRGs for hexachlorobenzene, antimony, and mercury.

**Response:** Please see response to Comment 14.

**DTSC Response to Comment 16:** This comment was not addressed.

Clarification on the ERA PRGs for hexachlorobenzene, antimony, and mercury was not provided. Table E3-1, Appendix E, does not provide the supporting information.

**Response:** The response to Comment 16 directed the reader to response to Comment 14c. The response to Comment 14c provided applicable general information about the processes used to derive the ERA PRGs; however, the response to "Comment 16" should have also specifically referred to Table E4-5 as providing the supporting information for the ERA PRGs for hexachlorobenzene, antimony, and mercury, as derived for Site 1111.

The response to Comment 14 apparently created some uncertainty for the reviewer (see part "c" of Response to Comment 14 earlier in this document). The bullet items (listed earlier in this document as a response Comment 14c) provide a recap of technical points germane to the derivation of the ERA PRGs. As also stated previously after the bullet items, based on the series of communications, we respectfully request that HERD restate their concern(s), if concerns are still present, with the ERA PRGs derived in the OU 5 FS.

## DISCUSSION AND CONCLUSIONS

**Comment 17:** This Draft Feasibility Study discusses the proposed remedial alternatives for Sites 1A-1, 21, 1111, and 12 Area, Site 13. HERD recommends a more concise and efficient methodology for calculating proposed remedial goals. In addition, HERD does not accept the use of 3,500 mg/kg as the acceptable concentration for an occupational scenario. HERD recommends using the residential or industrial soil PRGs established by EPA Region 9 (EPA, 2004) or the EPA Adult Lead Model (EPA, 2003). The document should also present additional discussion on the calculation of the 95% UCL, especially in areas where the distribution of the data indicates that there could be hot spots. HERD's comments on the apparent inconsistencies in the ecological remedial goals require some clarification.

**Response:** Please see specific responses to comments.

**DTSC Response to Comment 17 (Discussion and Conclusions):** The Response to Comments failed to address specific comments 4 and 6. The remaining comments, however, were adequately addressed. The Feasibility Study for OU-5 will be deemed acceptable after HERD reviews and approves the responses to specific comments 4 and 6.

**Response:** Comment 4 of the original comments was not addressed because Site 21 was removed from the Feasibility Study, as discussed during the FFA meeting held 24 May 2005 and as described at the top of Page 1 of these responses.

With regard to Comment 6, please see specific response to Comment 16.

***[The following text/comments were provided by the California Department of Fish and Game (Victoria Lake) in a letter to Tayseer Mahmoud, dated March 28, 2005]***

The Department of Fish and Game-Office of Spill Prevention and Response (DFG-OSPR) received the above-referenced document on February 15, 2005. DFG-OSPR previously reviewed the remedial investigation report (RI), Tier-1 screening-level ecological risk assessment, and Tier-2 baseline ecological risk assessment (BERA) for Operable Unit (OU) 5.

**BACKGROUND**

Camp Pendleton is an active military facility that occupies approximately 125,000 acres in the northwest corner of San Diego County. The Base has been conducting military training since World War II, and is the Marine Corps' primary amphibious training center. Aside from the nearly 10,000 acres that is developed, most of the base is largely undeveloped land that is used for training.

Camp Pendleton lies within the coastal Peninsular Range of southwestern California. The terrain of the base is varied, ranging from sandy shores and coastal plains to rolling hills, major stream systems, and mountains. Habitat types include beach and dune communities; shrublands such as sage scrub, chaparral, and bluff scrub; riparian; grasslands; oak woodlands; and coastal salt marsh. Special-status wildlife species that occur at Camp Pendleton include 14 federally listed threatened or endangered species, 5 state-listed threatened and endangered species, 1 species both federally- and state-listed, and over 55 state-listed Species of Special Concern. Special-status plants include 3 species both state and federally listed as endangered, 1 species federally threatened, and 18 species considered rare but having no official listing status.

Operable Unit (OU) 5 sites are concentrated in the southeastern part of Camp Pendleton in the vicinity of Vandegrift Boulevard. Site 1A-1, the refuse disposal area adjacent to Site 1A, and Site 1111, a burn ash and refuse disposal area, are characterized by contaminants in soils at levels that may pose risks to ecological receptors. Contaminants present in soils are primarily metals, dioxins, pesticides, and volatile organic compounds (VOCs).

Site 1A-1 is a debris disposal area approximately 1.5 acres. It is located within the known foraging area of nesting Coastal California Gnatcatchers, which is federally listed as threatened and a California species of concern. The site is also within the ecologically sensitive floodplain area of Pilgrim Creek. Four chemicals are present in soil at concentrations that are predicted to pose a potentially significant hazard to ecological receptors: antimony (invertivorous birds), lead (invertivorous and omnivorous birds), zinc (insectivorous birds), and dioxins (birds and small mammals).

Site 1111 has habitat suitable for the state- and federally-threatened Least Bell's Vireo. The habitat is also suitable for the southwestern arroyo toad, which is federally-listed as endangered and a California species of concern. Four chemicals are present in soil at concentrations that may pose a potentially significant hazard to ecological receptors: antimony (birds and small mammals), mercury (herbivorous and omnivorous small mammals), dioxins (herbivorous and omnivorous small mammals), and hexachlorobenzene (omnivorous small mammals).

The review conducted by DFG-OSPR focused on biological resource and ecological risk considerations as part of our role as a natural resource trustee for the State of California.

**SPECIFIC COMMENTS**

**Comment 18: Site 1111, Section ES.3 and Section 4.1.1 Site Description and History.** The correct listing status for the Least Bell's Vireo is endangered under both the state and federal Endangered Species Acts. In addition, the arroyo toad is federally listed as endangered and considered a California species of concern.

> **Response:** The description of the listing status for these species has been corrected in the Draft Final.

**Comment 19: Site 1A1, Section 2.1.2.5 Ecology.** A reference is cited for a biological assessment conducted for Site 1A1 (IT, 1999). This reference, however, is not listed in the References section. Please provide a copy of the biological assessment so that it can be reviewed for its completeness and adequacy.

> **Response:** The reference list has been updated for the Draft Final; the citation is provided below. A copy of the biological assessment was provided to the CDF&G in 1999.
>
> Reference cited:
>
> IT. 1999. Marine Corps Base Camp Pendleton, California, Biological Assessment for Sites 1A, 1D, 1DE, 1F, 2A, and 30. 20 May.

**Comment 20: Site 1A1, Section 2.1.7 Summary of RI Conclusions and Section 2.6.2.3 Alternative 1A1-3.** As the project plan develops, please coordinate with both United States Fish and Wildlife Service (USFWS) and DFG to identify appropriate biological monitoring and mitigation measures for impacts to the Coastal California Gnatcatcher.

> **Response:** As plans for specific remedial actions are developed, Base biologists and remediation contractors will coordinate with the FFA Team and appropriate agencies to ensure that biological monitoring and mitigative measures are identified and implemented (if necessary), to protect the Coastal California Gnatcatcher.

**Comment 21: Site 1A1, Section 2.4.3 Containment.** If a remedial action is selected that disturbs natural habitat, please provide the revegetation specifications in the project plan and submit to DFG-OSPR for review. The site should be revegetated to provide habitat suitable for the Coastal California Gnatcatcher. Topsoil can be stockpiled during the excavation effort for this purpose. If a shift in habitat type must occur to accommodate an engineered cap, the loss of special-status species habitat will require mitigation. Revegetation should be conducted using native plant species.

> **Response:** As plans for specific remedial actions develop, Base biologists and remediation contractors will develop a project plan that duly considers the potential disruption of existing habitat (through time and across an area) or the potential loss of existing habitat (and necessary mitigation), and natural or engineered restoration processes. The project plan will be provided to DFG-

OSPR for review sufficiently prior to planned implementation, to ensure that any necessary modifications to the plan can be incorporated.

**Comment 22: Section A3.2.3 Biological Resources ARARs and Section A3.1.4 Biological Resources Conclusions.** In several places throughout the text it mentions that no threatened or endangered species have been observed at the site under study, except for the California Coastal Gnatcatcher at Site 1A-1. Please elaborate on the nature of the biological studies that have been completed. Site-specific focused surveys should be performed to identify all special-status species with potential to occur in the area, including those that are considered sensitive to the State. Information on special-status species with potential to occur in the area can be obtained from the DFG's California Natural Diversity Database (CNDDB) at http://www.dfg.ca.gov/whdab/html/cnddb.html. Please call (916) 324-3812 with regard to any requests for additional information about the CNDDB. The Camp Pendleton Integrated Resources Management Plan is another useful source of information.

**Response:** As an outcome of ongoing activities by Base biologists, the preparation of, and updates to, the Base's Integrated Natural Resource Management Plan and previous biological investigations, the Base believes that it is adequately understood which special-status species have a potential to occur in the site-specific areas.

As indicated in the response to Comment 20, Base biologists and remediation contractors will coordinate with the FFA Team and appropriate agencies to ensure that biological monitoring and mitigative measures are identified, and implemented (if necessary), to protect the special-status species that potentially occur in the site-specific areas.

**Comment 23: Table A3-2 Potential State Location –Specific ARARs.** This table represents an incomplete list of potential State location-specific ARARs. An updated list of DFG ARARs is enclosed. Please include these ARARs in Table A3-2.

**Response:** The updated list was reviewed. Requirements that may be pertinent to the OU 5 sites were included. Many that were not directly addressed to OU 5 sites, were less stringent than federal ARARs, or were not necessary guidance for the OU 5 sites were not included. The document has been updated and the revised Table A3-2 is attached.

## CONCLUSIONS

**Comment 24:** After reviewing the FS, we generally concur with the excavation and capping remedies proposed by the Navy. We support remedial measures that would reduce impacts to biological resources. Mitigation for habitat destruction that results from cleanup activities may be required of the Navy and should be coordinated with the U.S. Fish and Wildlife Service for review and comment. We request that the final FS be prepared to address the specific comments provided herein. We also request that future remedial activity and biological restoration be coordinated with DFG-OSPR because of the ecological sensitivity of the OU5 sites. If you have any questions or require further details, please contact Victoria Lake at (916) 324-9811, or via email (vlake@ospr.dfg.ca.gov).

**Response:** Comments and perspectives noted.

**DRAFT OPERABLE UNIT 5 FEASIBILITY STUDY**
**FOR SITES 1A-1, 21, 1111, AND 12 AREA, SITE 13**
**MARINE CORPS BASE CAMP PENDLETON, CALIFORNIA**

**RESPONSE TO COMMENTS FROM**

**THE CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD,**
**SAN DIEGO REGION**
**(RECEIVED 25 APRIL 2005) (REFERENCE NUMBER SMC: 30-0456.05:GRIFB )**

***[As discussed during the FFA meeting held 24 May 2005, comments and responses relating to Site 21 have been removed from this document and will be addressed separately in a Technical Meeting and included in a separate report for Site 21.]***

***[The following comments have been sequentially numbered to facilitate discussion.]***

The California Regional Water Quality Control, San Diego Region (Regional Board) has reviewed the "Draft Operable Unit 5, Feasibility Study for Sites 1A-1, 21, 1111, and 12 Area, Site 13, Marine Corps Base Camp Pendleton, California" (FS) prepared by Parsons and dated January 24, 2005. The FS presents an overview of findings and conclusions of historical environmental activities, development of remedial action objectives and goals, identification of general response actions, evaluation of technology process options, development and detailed analysis of remedial alternatives (RA), and a comparative analysis of remedial alternatives for Installation Restoration (IR) Sites 1A-1, 21, 1111, and 12 Area, Site 13.

Pursuant to the Porter Cologne Water Quality Control Act (CWC, Section 13001), the Regional Board is the principal state agency with primary responsibility for the coordination and control of water quality issues within the San Diego Region boundaries, described in CWC Section 13201. The objective of this letter is to document comments and concerns regarding water quality issues, which are provided below and categorized as either general or site specific. General Comments are universal issues that relate to multiple sites. Site-Specific Comments are site-specific issues that are further categorized as General or Section Specific Comments. Site-Specific, General Comments are issues that need to be addressed and/or are addressed in multiple sections of the FS, including the Executive Summary. To eliminate redundancy, the issues are presented once in this letter under the Site Specific, General Comments; however all the relevant sections of the FS need to be revised accordingly. The Site Specific, Section Specific Comments are issues addressed in one Section or Subsection of the FS.

## GENERAL COMMENTS

**Comment 1:** IR site descriptions should be augmented to identify the Regional Board Hydrologic Unit, Area, and Subarea (Regional Board Basin Plan, 1994) in which each site is located. Please note that according to the FS IR Sites 21 and 12 Area, Site 13 are located within the Santa Margarita Hydrologic Unit, yet according to historical submittals, the IR Sites are located in the San Luis Rey Hydrologic Unit (IT Corp., 1997).

Please rectify the discrepancy or provide clarification, whichever is appropriate. Additionally, site descriptions should include relevant information regarding the most proximal and downgradient production wells within the same Hydrologic Unit in which the subject IR site is located. Currently, some site descriptions provide information for the most proximal production wells, some of which appear to be located in a Hydrologic Unit adjacent to the Hydrologic Unit that the subject IR Site is located within.

> **Response:** Site descriptions have been augmented with the Regional Board Hydrologic Unit, Area, and Subarea (Regional Board Basin Plan, 1994) in which each site is located. 12 Area, Site 13 is located within the Upper Ysidora Hydologic Subarea (2.13) of the Ysidora Hydrologic Area (2.10) of the Santa Margarita Hydrologic Unit (2.00). The prior IT conclusion is incorrect.

**Comment 2:** Relevant FS subsections and tables providing detailed and comparative analyses of the 21-3 and 1111-G3 remedial alternatives require revision to specifically and solely outline the benefits and costs of Monitored Natural Attenuation (MNA) implementation. Currently the discussions present information regarding RA 21-2 and RA 1111-G2 as well as RA 21-3 and RA 1111-G3. As an example, according to Subsection 3.6.3.1 "The institutional controls component of the alternative would protect human health and the environment. MNA would allow a periodic assessment of the ground water quality, facilitate plume tracking, and permit periodic evaluation of additional actions, if necessary." The subject subsection reiterates remedial alternative 21-2 issues and does not specifically identify the added benefit of MNA implementation. As presented, the benefits and cost associated with the remedial alternatives (21-2 and 21-3, and 1111-G2 and 1111-G3) are combined and those associated with Remedial Alternatives 21-3 and 1111-G3 are not readily distinguishable.

> **Response:** As previously noted, Site 21 will not be included in the OU 5 Draft Final FS because the FFA Team plans to decide if specific additional data is needed to complete the Site 21 FS. Issues relevant to Site 21 will be addressed in a separate document.
>
> For Site 1111 please note, the subject criteria in the comment is a threshold criteria, and both Alternative 1111-G2 and 1111-G3 meet the threshold. However, MNA would provide the added monitoring and analysis necessary to quantify the specific attenuation mechanisms taking place in the subsurface, to assess the effectiveness of the remedy over time, and to better predict the effectiveness of the remedy into the future. There would be no difference in the actual subsurface physical processes, but the added cost of the MNA remedy would yield a higher degree of confidence in the analysis of plume behavior, which may be worth the added cost of the remedy. Alternatively, if simply tracking contaminant concentrations is considered adequate for the site, then selection of the alternative with ICs and long-term monitoring may be appropriate.

**Comment 3:** Remedial alternatives 21-4 and 1111-G4 for IR Sites 21 and 1111 involve the addition of a carbon substrate into the subsurface environment to provide indigenous microorganisms with an additional source of organic carbon and hydrogen, and to establish/promote anaerobic conditions that will stimulate degradation of site related pollutants. Following are several issues regarding these proposed remedial alternatives.

1. Are indigenous microorganisms that are capable of degrading site-specific contaminants present at the sites?
2. If the indigenous microorganisms are present at the sites, are they present at sufficient quantities to degrade the concentrations of contaminants at the sites?
3. Are the existing and estimated future concentrations of organic carbon and hydrogen naturally occurring in the subsurface environment limiting the ability of the microorganisms to degrade site related contaminants?
4. What existing and future environmental factors are currently limiting the microorganism's ability to degrade site related contaminants?

**Response:** Each point is addressed below:

**Point 1: Are indigenous microorganisms that are capable of degrading site-specific contaminants present at the sites?**

Current literature suggests that anaerobic reductive dechlorination is carried out by only a few metabolic classifications of bacteria, including methanogens, sulfate-reducing bacteria, and dechlorinating bacteria. Anaerobic bacteria such as methanogens and sulfate-reducing bacteria appear to be ubiquitous in the subsurface environment (Chapelle, 1993). See *Principles and Practices of Enhanced Anaerobic Bioremediation of Chlorinated Solvents,* http://www.afcee.brooks.af.mil/products/techtrans/bioremediation/downloads/PrinciplesandPractices.pdf

At Site 1111, there is a limited amount of TCE but otherwise no indication of reductive dechlorination by-products of PCE biodegradation. However, site conditions do not indicate the sulfate-reducing or methanogenic conditions needed for the reductive dechlorination process. TOC is relatively low (less than 10 ppm), dissolved oxygen is above 1 ppm at four of the six wells, and there is no detection of methane. The addition of a carbon substrate will very likely establish the reducing conditions needed to stimulate anaerobic reductive dechlorination.

**Point 2: If the indigenous microorganisms are present at the sites, are they present at sufficient quantities to degrade the concentrations of contaminants at the sites?**

Microorganism populations are probably currently insufficient to complete the reductive dechlorination process under ambient conditions (as evidenced by virtually no PCE degraded at Site 1111). However, the purposes of adding the carbon substrate are to (1) stimulate biological growth to the extent that primary electron acceptors (oxygen, nitrate, iron, manganese) are depleted and strongly reducing conditions favorable for reductive dechlorination are established, and (2) provide the microorganisms with a sufficient food source so that the population will increase.

**Point 3: Are the existing and estimated future concentrations of organic carbon and hydrogen naturally occurring in the subsurface environment**

**limiting the ability of the microorganisms to degrade site related contaminants?**

It appears that the ambient TOC levels at the sites are insufficient to drive the natural systems to complete the degradation of PCE and TCE. Site 1111 appears to be mostly aerobic and has low TOC, so reducing conditions have not been established.

**Point 4: What existing and future environmental factors are currently limiting the microorganism's ability to degrade site related contaminants?**

Ultimately Site 1111 lacks sufficient biodegradable carbon to use up the preferred electron receptors (oxygen, nitrate, iron/manganese and some of the sulfate) so that reductive dechlorination can occur. Site 1111 has very low natural TOC, and needs the carbon substrate to deplete the preferred electron acceptors (notably oxygen).

References Cited:

Chapelle, F.H. 1993. *Groundwater Microbiology and Geochemistry*. New York: John Wiley & Sons.

**Comment 4:** A phased investigation to address the above noted issues and to ultimately evaluate the efficacy of the proposed approach seems warranted prior to implementing the subject remedial alternatives. Additionally, following are several water quality issues that must be addressed if these remedial alternatives are selected to ensure remedial alternative implementation does not exacerbate current site conditions and/or have adverse consequences.

- The carbon substrate must be characterized to determine if the substrate contains constituents that may pose a threat to water quality.
- A site specific investigation of the geochemical processes that are anticipated to occur if the carbon substrate is applied to the subsurface environment. The objective of the investigation will be to understand the chemical interaction of the substrate with all components and elements of the subsurface environment, identify interaction byproducts, and evaluate the potential for adverse effects, such as the mobilization of naturally occurring metals.
- The quantity of carbon substrate to be applied needs to be sufficient to achieve the remedial alternative objective but not be excessive so that the unused substrate would become a waste.

**Response:** Each point is addressed below:

**Point 1: The carbon substrate must be characterized to determine if the substrate contains constituents that may pose a threat to water quality.**

Carbon substrates proposed are non-toxic. At Site 1111 the plan is to use mulch or compost such as would be used in a vegetable garden. Mulch or compost can be easily tested using a standard TCLP test.

**Point 2: A site specific investigation of the geochemical processes that are anticipated to occur if the carbon substrate is applied to the subsurface environment. The objective of the investigation will be to understand the chemical interaction of the substrate with all components and elements of the subsurface environment, identify interaction byproducts, and evaluate the potential for adverse effects, such as the mobilization of naturally occurring metals.**

The proposed approach at Site 1111 will convert the groundwater in the treatment zone to strongly reducing conditions. This change in geochemistry will indeed cause geochemical changes, including the likely dissolution of metals (notably iron, and possibly trace metals). However, this effect is local, dissolved components of petroleum spills usually extend for no more than a few hundred feet from the point of application (Rice et al, 1995), and carbon amendments are similarly attenuated. Down-gradient from the injection point, bacteria deplete the dissolved carbon and conditions revert to ambient, resulting in the precipitation of any mobilized metals. This phenomenon has been well documented for major cations at fuel-contaminated sites (Baedecker et al., 1988). Regulatory agencies have at times expressed concern over the possibility of trace metals. A carbon substrate amended site at Travis AFB California was monitored for four years for the possibility of arsenic, selenium, and manganese mobilization, but none of these trace inorganics were ever detected. Further, monitoring conducted during pilot scale testing will ensure that if there is any unexpected mobilization outside the treatment zone, it will be detected and appropriate measures can be taken to control it. Finally, only a small amount of mulch or compost will be added at the bottom of the excavation at Site 1111. The main remedy at Site 1111 is excavation, and the substrate addition is a minor component to that would help reduce the low levels of PCE in the groundwater. The Site 1111 carbon substrate amendment will be designed to limit the extent of any geochemical impacts.

**Point 3: The quantity of carbon substrate to be applied needs to be sufficient to achieve the remedial alternative objective but not be excessive so that the unused substrate would become a waste.**

Any impacts of carbon substrate addition would be local, probably extending no more than a few hundred feet or less down-gradient from point of application. At Site 1111, mulch and compost amendments are generally considered to release dissolved carbon for about 5 years, which is the expected time required to treat the PCE at the site.

References Cited:

Rice, D. W., R. D. Grose, J. C. Michaelsen, B. P. Dooher, D. H. MacQueen, S. J. Cullen, W. E. Kastenberg, L. G. Everett, and M. A. Marino, 1995, California Leaking Underground Fuel Tank (LUFT) Historical Case Analyses, Report submitted to the California State Water Resources Control Board Underground

Storage Tank Program and the Senate Bill 1764 Leaking Underground Fuel Tank Advisory Committee, 20 pp.

Baedecker, M.J, I.M. Cozzarelli, R.P. Eganhouse, D.I. Siegel, and P.C. Bennett, 1993. "Crude oil in a shallow sand and gravel aquifer biogeochemical reactions and mass balance modeling in anoxic groundwater," *Applied Geochemistry*, 8:569-586.

**Comment 5:** From a water quality perspective, the proposed soil and ground water remedial goals are not in accordance with the Porter-Cologne Water Quality Control Act, State Water Resources Control Board (State Board) Resolution 92-49, and the Regional Board Cleanup and Abatement Policy (Regional Board Basin Plan, 1994, Section VI) and are deemed to be unacceptable from two perspectives. First, the proposed approach involves attaining remedial goals at proposed site-specific point(s) of compliance downgradient of a site. Such an approach is not in accordance with the above noted state law and policies that require compliance with cleanup levels throughout the plume or area of contamination, not at a point(s) of compliance. Secondly, Appendix C presents the application and results of environmental models to predict the fate and transport of contaminants and establish soil and ground water remedial goals. To achieve compliance with requirements with state laws, regulations, and policies; the Regional Board establishes preliminary remedial goals for water at background concentrations. If the discharger demonstrates background concentrations are not attainable due to technologic and economic limitations, cleanup goals are established at concentrations that are as close to background as technologically and economically feasible and are protective of the <u>most sensitive</u> designated beneficial use of waters of the state. Remedial goals for soil are leachable/mobile pollutant concentrations equal to background concentrations. If achievement of background concentrations is not technologically and economically feasible, cleanup levels are established at leachable/mobile pollutant concentrations that do not exceed the water remedial goals described above (Regional Board Basin Plan, 1994, Section VII). Hence it is the Regional Board's position that the soil and water remedial goals presented in the FS are unacceptable from a water quality perspective and must be revised to comply with state environmental laws, regulations, and policies. The above referenced State Board and Regional Board resolutions and policies are available on the Regional Board website: http://www.waterboards.ca.gov/sandiego/programs/basinplan.html.

**Response:** As previously noted, Site 21 will not be included in the OU 5 Draft Final FS because the FFA Team plans to decide if specific additional data is needed to complete the Site 21 FS. The issues raised in the comment are less significant at the other Sites in the FS (Sites 1A-1, 1111, and 12 Area, Site13), as discussed in text below. For Site 21, DON and the RWQCB will ultimately reach agreement on remedial goals for the site during the time needed to perform additional technical data gathering.

For the other sites, note that the feasibility of remediating to background was evaluated in the FS. See Section A2.2.1.1. Groundwater contamination at the sites will be reduced to MCLs or background concentrations through active or non-active alternatives given enough time. For Site 1111, once the known soil source is removed, the timeframe to achieve MCLs or background is estimated to be relatively short (3 to 5 years). At Site 13, concentrations of primary COCs (TCE and benzene) are at or below 10 µg/L, and the site is located such that

there is no expected exposure pathway to human or ecological receptors. Therefore, it is not considered economically feasible to incur significant costs to achieve cleanup to below a risk-based criteria. Any acceptable alternative will, however, ensure that the plume continues to pose no risk or threat to beneficial-use water (i.e. no significant migration), as monitored in appropriate site wells.

The use of the term "point of compliance," will be removed from the document, and instead the text will reflect that site monitoring wells will be used to ensure that the plume is not migrating offsite. The goal will be to obtain the lowest achievable COC detections in groundwater.

Regarding the application of SWRCB Resolution No. 92-49, DON has found that it is not more stringent than federal ARAR provisions at Cal. Code Regs. tit. 22, §66264.94. In order for a state requirement to be an ARAR it must be more stringent than federal ARARs. Please see section A2.2.1.2 for a complete discussion of the DON and State positions on SWRCB Res. No. 92-49. The federal ARAR at Cal. Code Regs. tit. 22, §66264.94 also requires cleanup to background unless technologically and economically infeasible. The DON has determined that most of the Porter Cologne Act provisions are potentially ARAR enabling legislation that is the authority behind the Basin Plan. However, for this CERCLA action, it is considered likely that the agreed-to remedy will meet the RWQCB's requirements and that any disagreement regarding interpretation of this ARAR will have no bearing on the implementation of the actual remedy. As discussed in the FS, the site is considered protective of human health and the environment even in its current state. Removal of residual product combined with natural attenuation processes are expected to result in background levels given enough time, and the proposed alternatives require groundwater monitoring.

**Comment 6:** Proposed remedial alternatives for IR Sites 21 and 1111 include expansion of the existing ground water monitoring networks by installing 5 wells at IR Site 21 (3 wells within the shallow aquifer and 2 wells within the deep aquifer) and up to 4 wells at IR Site 1111. The proposed ground water monitoring networks will not allow the delineation and monitoring of plumes in three dimensions, which is discussed in numerous environmental guidance documents (US EPA, 1988a; USEPA, 1988b; USEPA, 1992; and USEPA, 1999). The need to monitor ground water plumes in three dimensions also is discussed in "Performance Monitoring of MNA Remedies for VOCs in Ground Water" (USEPA, 2003), which the FS proposes that future Remedial Action/MNA Work Plans for IR Sites 21 and 1111 will comply with. An adequate and appropriate ground water monitoring network shall have to be designed and installed at IR Sites 21 and 1111 in the near future based on site conditions, contaminant fate and transport issues, and locations of sensitive receptors.

**Response:** The proposed initial groundwater monitoring well networks for Site 1111 does take into account the known existing site conditions, contaminant fate and transport issues, and receptor locations, based on the existing conceptual site models. As stated in the FS, the proposed initial monitoring well network is intended to establish baseline concentrations of contaminant distribution throughout the VOC plume and determine needed modifications to the initial network. New data from sampling events will be continually incorporated into the conceptual site model and provide the basis to refine the model and modify

monitoring well locations, parameters and frequencies. The DON agrees that the groundwater monitoring well networks should provide adequate plume resolution in three dimensions based on site conditions, and proposes to include vertical profiling of soil and groundwater concentrations during monitoring well installation, to ensure the optimum placement of well screens for plume and remedy performance monitoring. The specific details of the monitoring well network design and installation would be addressed in the remedial action groundwater monitoring work plans.

**Comment 7:** Proposed remedial alternatives for IR Sites 21 and 1111 include long-term ground water monitoring until site related plumes are no longer capable of migrating at concentrations that exceed remedial goals. Note that environmental guidance documents discuss the performance of ground water monitoring activities following achievement of remediation goals to ensure contaminant concentrations are stable and do not rebound (USEPA, 1988a; USEPA, 1988b; US EPA, 1999).

**Response:** The DON acknowledges that groundwater monitoring activities would continue for a period of time following achievement of remediation goals to ensure contaminant concentrations remain stable and do not rebound. This would be evaluated at the CERCLA 5-year review.

**Comment 8:** The FS presents the proposed frequencies and locations for long-term monitoring of target zones within ground water plumes at IR Site 21, 1111, and 12 Area, Site 13. The rationale for the proposed frequencies and locations must be provided in the ground water monitoring work plan. Site-specific factors that need to be considered in establishing the frequencies and locations of ground water monitoring activities that are technically and scientifically defensible include, in part:

- hydrogeologic conditions,
- minimization of data redundancy,
- establishment of seasonal trends,
- rate of plume migration,
- proximity of sensitive receptors,
- variability of historical data,
- degree of confidence required,
- ability to detect plume expansion,
- ensure attainment of remedial objectives,
- detect new releases,
- ability to detect changes in the environmental conditions in a timely manner, and
- evaluate efficacy of natural attenuation processes (USEPA, 1988a; USEPA, 1988b; USEPA, 1992; USEPA, 1999).

**Response:** The DON agrees that the proposed monitoring well networks should consider all of the above factors in establishing the frequencies and locations of groundwater monitoring activities. As discussed in Response to Comment 6, the specific details of the monitoring well network design and installation would be addressed in the remedial action groundwater monitoring work plans.

## APPENDIX A, ARARS

**Comment 9:** Throughout Appendix A it is noted that DoN has evaluated and determined that cleanup to background contaminant concentrations in soil and water is not technologically and economically feasible. To our knowledge the technologic and economic infeasibility of achieving background contaminant concentrations has not been demonstrated.

> **Response:** The DON agrees that cleanup to background levels or lowest achievable level of constituents is necessary, unless such restoration proves to be technologically or economically infeasible and an alternative cleanup level of constituents will not pose a substantial present or potential hazard to human health or the environment. The DON has evaluated cleaning up to background and it has been determined that background levels will be met over time (Refer to response to Comment 5). It is not considered economically feasible to incur significant costs to achieve cleanup to below a risk-based criteria. That is, active cleanup measures that go beyond risk-based goals are not necessary for protection of human health, the environment or for the protection of water quality. However, background levels are expected eventually for all alternatives.
>
> Any acceptable alternative will ensure that the plume continues to pose no risk or threat to beneficial-use water (i.e. no significant migration), as monitored in appropriate site wells.

**Comment 10:** Throughout Appendix A, there are discussions that reference the "state" that appear to pertain to one of the two state agencies that are signatories to the Federal Facilities Agreement (FFA). Please revise the discussions to specifically indicate whether the discussion is with regards to the Department of Toxic Substances Control (DTSC), Regional Board, or both.

> **Response:** Most of the references to the "state" refer to both (or even more) of the state agencies, including the Department of Fish and Game, the air boards, and any other state agency involved. For example, "State" ARARs is a general term that could be applied to any of the state agencies and therefore, is not specific to either the DTSC or RWQCB. Waters of the "state" are just that, and cannot be distinguished between the RWQCB or the DTSC. The agree-to-disagree language included in Section A2.2.1.2 has been agreed to by the attorneys for both the DON and the state. After reviewing Appendix A, there were no instances where the text could be revised to indicate it was specifically regarding the DTSC or RWQCB.

## APPENDIX C

**Comment 11:** Appendix C contains several tables presenting the modeling efforts. Whereas the tables contain useful information it is unclear which of the input parameters are based on site-specific values and which values are acquired from reference documents. In these Tables, please distinguish these two different sources of parameters values.

**Response:** All pertinent tables in Appendix C have been revised to specify which modeling input parameters are based on site-specific values and which parameters are based on technical literature values for each input parameter.

## SITE SPECIFIC COMMENTS – IR SITE 1A-1

## SECTION SPECIFIC COMMENTS

**Comment 12: ES.1, Page ii:** The description of production wells needs to be augmented to provide the hydrologic relationship between the production wells and IR Site 1A-1 and well identification numbers. If the described wells are not hydrologically down gradient of IR Site 1A-1, the paragraph needs to be augmented to indicate the distance between IR Site 1A-1 and the most proximal down gradient ground water production well(s).

**Response:** The cited text will be augmented with the requested information. The production wells in the San Luis Rey Basin are hydrologically downgradient of the site.

**Comment 13: ES.1, Page iii:** The first paragraph, last sentence, presents the finding that "Groundwater is not present in the bedrock underlying most of the waste fill soils." The sentence needs to be revised from two perspectives. First, as worded it is unclear if ground water was encountered in bedrock underlying some of IR Site 1A-1 waste. Secondly, numerous borings were advanced at IR Site 1A-1 during historical field activities (Parsons, 2004), however the drilling method used (Direct Push) was not capable of penetrating bedrock. To our knowledge, the presence of ground water in bedrock has not been investigated at IR Site 1A-1. Hence, the above referenced sentence requires revision to address these two matters.

**Response:** The cited sentence actually states that "Groundwater is not present directly beneath most of the waste fill soils." The field investigation found that, for most of the waste area, groundwater was not encountered, and as the borings were advanced, hard bedrock was eventually encountered under the waste. However, as noted in the RI, there is groundwater present under the Pilgrim Creek streambed, and a portion of the Site 1A-1 waste overlies the edge of the streambed. With regard to groundwater within the bedrock, it is correct that the direct push method was unable to advance into the hard igneous bedrock. Although there has been no in-depth study of whether there is groundwater in the bedrock, it is reasonable to assume, based on site mapping and observation of the density of the bedrock, that there is not significant flow of groundwater through bedrock, particularly relative to the known groundwater flow through streambed alluvium.

**Comment 14: ES.1, Page iii:** According to the fifth bullet, ground water is not present beneath waste soils. The finding is based on a temporally limited ground water investigation and does not take into consideration fluctuations in the water table elevations at IR Site 1A, which is located approximately 750 feet down gradient of IR Site 1A-1. Findings of historical ground water investigations at IR Site 1A indicate the water table was intermittently encountered as shallow as less than 1 foot below grade surface (bgs; International Technology (IT) Corp., 2001b). Projecting these findings to

IR Site 1A-1, one can logically conclude that during and following significant rain events, it is highly probable that ground water exists beneath IR Site 1A-1 waste.

> **Response:** Note that the text in questions says "Groundwater is not present beneath *most* of the waste soils." It is acknowledged that water table fluctuations will affect the portion of the waste material overlying groundwater. For example, in the description of alternative 1A1-3, if waste is capped in place, it is recommended that the portion of the waste that is within the floodplain be moved and placed on higher ground prior to cap construction.

**Comment 15: ES.1, Page vi:** The fifth paragraph presents a possible fifth alternative that involves the combining and capping of IR Site 1A-1 and 1A wastes. An additional remedial alternative that may be practicable, involves the joint excavation and Off-Base disposal of IR Site 1A-1 and 1A wastes. The concurrent implementation of remedial actions at IR Site 1A-1 and 1A may have significant environmental and financial benefits, and should be considered.

> **Response:** If the DON determines that combining wastes from Sites 1A and 1A-1 is viable, a supplemental FS would be necessary, which would be reviewed by the FFA Team.

**Comment 16: Subsection 2.1.3.1:** According to the last sentence of Subsection 2.1.3.1 "Analytical testing and field observations do not indicate the presence of debris in the Pilgrim Creek streambed." This statement seems to contradict site conditions described on Page iii, fourth bullet, and Subsection 2.1.7, fourth bullet; which present the finding that sediment analytical results indicate waste has eroded from IR Site 1A-1 and subsequently deposited in the streambed. If appropriate, please correct this apparent discrepancy.

> **Response:** The sentence has been corrected to "Field observations do not indicate the presence of debris in the Pilgrim Creek streambed, although trace concentrations of COPCs in the sediment samples indicate erosion of waste materials may have had a minor impact to streambed sediments directly adjacent to waste material."

**Comment 17: Subsections 2.1.3.2, 2.1.4, 2.2.1, and A4.3:** Please augment these Subsections to include findings of historical analytical data that indicate the presence of relatively low concentrations of VOCs in ground water samples collected from monitoring well 1A-1, which is located between IR Sites 1A and 1A-1. Based on the hydrologic relationship between IR Site 1A-1 and well 1A-1, the absence of any known waste between IR Site 1A-1 and the well, and a correlation between the suite of VOCs detected in IR Site 1A-1 waste and in ground water samples from well 1A-1; one can logically conclude that the VOCs detected in ground water samples from well 1A-1 originated from IR Site 1A-1 waste. Additional ground water monitoring activities involving wells 1A-1 and 1A1MW-1 are required to evaluate the threat IR Site 1A-1 waste poses to the quality of waters of the state.

> **Response:** VOCs (i.e., TCE and TCA) were detected in one sampling event in July, 2000 in monitoring well 1A-1, located immediately upgradient of Site 1A. Since the July 2000 event, seven subsequent sampling events have shown no detectable contamination in this well. These subsequent sampling events were

conducted to confirm or refute the July 2000 results, and sufficient sampling has been conducted to determine that contaminants are not present in monitoring well 1A-1. According to the Site 1A Groundwater Technical Memorandum, dated February 2004 (SWDIV, 2004, Summary of Annual Groundwater Monitoring Results, IR Site 1A, MCB Camp Pendleton), the detections in July 2000 were likely caused by cross-contamination. Therefore, DON does not agree with the Board conclusion that VOCs detected in ground water samples from well 1A-1 during one of eight groundwater sampling events is an indication of contamination originated from IR Site 1A-1 waste. Note also that monitoring well 1A1MW-1, which is located immediately downgradient of Site 1A-1 exhibited no detectable contaminant concentrations at described in Section 2.1.3.2. This further reinforces the conclusion that the single detection in monitoring well 1A-1 was an anomaly.

**Comment 18: Subsection 2.6.2.3:** The proposed remedial alternative 1A1-3 includes the installation of engineered soil cover to contain site waste. As illustrated in FS Figures 2-1 and 2-2, and described in FS Subsections 2.1.2.1 and 2.1.2.2; IR Site 1A-1 is located in a relatively narrow small valley that is surrounded by hills, and is in the immediate vicinity of and a tributary to Pilgrim Creek. Such an environmental setting is most probably subjected to potentially significant erosive forces by surface water during and following periods of intense rain, which may adversely affect cover integrity. This issue is a significant negative aspect of remedial alternative 1A-1-3 that will require implementation of cover monitoring and maintenance as long as site waste poses a threat to receptors, which would seem to be a difficult issue to predict and generate representative long-term operation and maintenance cost estimates for. The remedial alternative cost estimate presented in FS Subsection 2.6.3.3 and Appendix F includes a 50-year life expectancy for the cap. Based on the type, concentration, and environmental persistence of contaminants present at the site; it is highly probable that site waste will pose a threat to sensitive receptors for a period of time exceeding 50 years. The FS should include a description of proposed environmental activities following the 50-year time period and associated costs for this remedial alternative.

**Response:** As stated in Subsection 2.6.2.3, the Alternative 1A1-3 proposed cap design involves grading the existing foundation to provide consistent sheet drainage and earthen swales and to ensure that waste materials and new cover soils are not subject to flooding from Pilgrim Creek. A proper design would minimize or eliminate the negative effects of cap erosion due to surface runoff and minimize the cap long-term operation and maintenance costs. The cost estimate for Alternative 1A1-3 based on a 50-year life expectancy is adequate for the purpose of the FS.

**Comment 19: Appendix C:** The IR Site 1A-1 description should be augmented to include the fact that dissolved pollutants were encountered in ground water samples collected from ground water monitoring well 1A-1, which is located down gradient of IR Site 1A-1 and up gradient of IR Site 1A. Whereas the source of pollutants is uncertain, based on the fact that the pollutants detected in the ground water sample are present in IR Site 1A-1 waste and there is no known source of pollutants between the two IR Sites, one can logically conclude that IR Site 1A-1 waste is the source of the pollutants detected in ground water well 1A-1.

**Response:** Please see response to Comment 17.

## SITE SPECIFIC COMMENTS – IR SITE 1111

### GENERAL COMMENTS

**Comment 20:** IR Site 1111 site descriptions throughout the FS need to be augmented to include the findings of a historical investigation that indicate IR Site 1111 is within the capture zone of Base Production Well 10S/04W-07R02 (IT Corp., 1993, Figures C-1, C-2, and C-3). Additionally, based on the design of Base production well 10S/04W-07R02, and the lateral and vertical discontinuity of sedimentary deposits encountered in the Santa Margarita alluvial aquifer down gradient of the Site (IT Corp., 2002), it is highly probable that the Base production well is in hydrologic communication with IR Site 1111 ground water. Based on site conditions and sensitivity, the ground water monitoring network (current and proposed in the FS) is inadequate, and will require significant augmentation to define and monitor the plume in three dimensions, and ensure protection of designated beneficial uses and compliance with ARARs.

> **Response:** The pertinent sections of the FS have been revised to include the IT Corporation findings that Site 1111 is located within the capture zone of Base production well 10S/04W-07R02.
>
> As discussed in response to Comment 7, the proposed initial monitoring well network is intended to establish baseline concentrations of contaminant distribution throughout the VOC plumes and to determine needed modifications to the network. The DON agrees with the Board that the groundwater monitoring well network for Site 1111 should provide adequate plume resolution in three dimensions in order to adequately protect the Base production well. The FS has been revised to reflect this discussion. The specific details of the monitoring well network design and installation to address these and any other concerns would be provided in the remedial action groundwater monitoring work plans.

### SECTION SPECIFIC COMMENTS

**Comment 21: ES.3, Page xii:** The third paragraph contains a description of the hydrologic relationship and distance of two Base production wells relative to IR Site 1111 but references one Base production well reference number (10S/04W-07R02). Please correct this apparent typographical error.

> **Response:** Section ES.3 has been revised to reflect the correct identification numbers for the two production well references (10S/04W-07R02 and 10S/04W-07H02).

**Comment 22: ES.3, Page xiii:** Based on site conditions and the presence of IR Site 1111 within the Santa Margarita River flood plain, discussions of Remedial Alternative 1111-S2 should be augmented to include implementation of Storm Water Best Management Practices (BMPs) to address site waste erosion and offsite transport by surface waters. Guidance documents regarding Storm Water BMPs are available on the State Board Website: www.swrcb.ca.gov/quality.html.

> **Response:** Note that Alternative 1111-S2 is not protective of ecological receptors and does not meet ARARs. The inclusion of BMPs will still not meet ARARs; therefore it is unlikely that this alternative would be chosen.

**Comment 23: ES.3, Page xiv:** Description of Remedial Alternative 1111-G2 specifically states that monitoring will be performed to ensure the ground water plume associated with IR Site 1111 does not migrate toward production well 10S/04W-07R02. Additional objectives of ground water monitoring activities are to ensure the plume does not adversely impact any production wells and/or nearby surface water bodies.

> **Response:** The text has been revised to include additional objectives of ensuring the plume does not adversely impact any production wells and/or nearby surface water bodies.

**Comment 24: Subsection 4.1.1:** Revise the second paragraph, first sentence to indicate that historical remedial actions performed at IR Site 3 involved offsite disposal of waste at IR Site 7 (Box Canyon Landfill).

> **Response:** Because Site 7 is closed and cannot receive additional waste, this information is not relevant to Site 1111.

**Comment 25: Subsection 4.1.1:** Augment the third paragraph to indicate whether or not contaminants encountered in IR Site 1111 ground water exceeds water quality objectives that are protective of aquatic organisms within adjacent and down gradient surface water bodies.

> **Response:** DON does not believe such water quality goals to be applicable to groundwater at the site, which is not contacted by ecological receptors. A brief review of the concentrations of COCs in site groundwater indicate a few inorganic chemicals measured in undiluted groundwater are present at concentrations greater than chronic-exposure benchmarks for aquatic life in surface waters. However, a thorough analysis of this would entail a fate and transport analysis of COCs to the nearest surface water body, and then an assessment of risk to the likely receptors in that surface water. Because groundwater COCs decrease sharply with distance from the known source, and because the groundwater COCs are likely in a steady state condition, it is not considered necessary to perform the above-described exercise. There are no complete pathways and no significant ecological hazards for exposure of aquatic organisms to the undiluted groundwater below Site 1111, and the chemicals in groundwater were not chemicals of potential concern for those organisms in direct contact with the contaminated soils (as documented in the Tier-1 and Tier-2 ecological risk assessments) and are not relatable to ecological hazards the site. Also, several of the surface-water benchmarks do not have regulatory standing – they are derived, conservative values intended for screening purposes – not as indicators of expressed adverse ecological effects.

**Comment 26: Subsection 4.1.2.2:** Revise the surface water description to include the presence of a stream, which appears to be a tributary to the Santa Margarita River, immediately adjacent to IR Site 1111, refer to FS Figure 4-1.

> **Response:** The text has been revised accordingly to indicate the presence of an ephemeral stream.

**Comment 27: Subsection 4.1.2.3:** The three bulleted items in this Subsection present the findings of subsurface investigations at several reference locations, such as

1111B02, that need to be illustrated in FS Figures for reference purposes. The description of site geology should be augmented to include the fact that IR Site 1111 is located within unconsolidated sediment that was deposited by the Santa Margarita River. Sedimentary bedforms associated with fluvial depositional environments are laterally and vertically discontinuous, and typically contain a wide range of sedimentary particles sizes, ranging from clay to boulders (Reading, H.G., 1980). Such bedforms and lithofacies have a profound effect on the behavior of ground water plumes at contaminated sites, even within Base boundaries (IT Corp., 2002), and need to be discussed.

> **Response:** Figure 3-2 has been revised to depict the locations of all referenced soil borings. Currently, the FS text identifies borings from Site 1111 with the prefix "1111" preceding the boring number (to match boring logs), whereas the figures drop the prefix "1111" in depicting boring locations because of space limitations. For example boring "1111B02" in the text and logs is shown as "B02" in the figure. In addition borings 1111TP1 through 1111TP3 (or TP1 through TP3) were missing from the Draft FS figures and have been added to the Draft Final (they are shown on Figure 5-12 from the RI). In addition, the current description of the soil conditions has been revised to provide a clearer picture of distribution of the gravel backfill and the burnt soil layer. The site geology has also been augmented to include a discussion of lateral and vertical discontinuity/variability of deposits typically found within these fluvial environmental.

**Comment 28: Subsection 4.1.2.4:** The hydrogeologic discussion should be augmented to discuss RI findings for IR Site 3 (IT Corp., 1993), located immediately south of IR Site 1111, to provide regional perspective of this matter. Whereas the information presented in the FS is relevant and appropriate, it is very localized, both laterally (ground water monitoring wells 1111MW-01, 1111, MW-02, and 1111MW-03) and vertically (~5' - 20' bgs). The inclusion of the hydrogeologic findings from IR Site 3 will provide a more regional perspective, both laterally and vertically. The historical investigation involved 11 ground water monitoring wells with screened intervals extending to a maximum depth of approximately 133 feet bgs. Additionally, the maximum and average hydraulic conductivities calculated at IR Site 3 are significantly higher than those calculated at IR Site 1111, and should be used in ground water models to generate more conservative results. According to the FS, the following are the maximum and average hydraulic conductivities, respectively, calculated at IR Site 1111: 138 ft/day and 51 ft/day, whereas those calculated at IR Site 3 are 1620 ft/day and 464 ft/day. This wide range of hydraulic conductivities is typical of sedimentary fluvial deposits in which paleochannels consisting of gravels with elevated hydraulic conductivity are present. The presence of such sedimentary deposits, encountered during historical field activities in the vicinity of IR Site 1111 (IT Corp., 1993), serve as preferential subsurface migration pathways that warrant consideration and investigation at contaminated sites. The higher hydraulic conductivities calculated at IR Site 3 are considered representative and should be used in addition to those encountered at IR Site 1111 for environmental modeling efforts.

> **Response:** A broad range of hydraulic conductivity values have been reported for the area around IR Site 1111 as noted in the comment. The Site 3 well closest to Site 1111, 3MW-02, is approximately 450 feet to the east of Site 1111 in a cross-gradient direction. Note that some calculated hydraulic conductivity

values for Site 3 wells reported by IT appear to be out of line and were flagged as having suspect or poor curves, including the 1,620 ft/day value at the top of the range cited in the comment. Average hydraulic conductivity values ranging from 610 ft/day to 977 ft/day appear to be representative of Site 3 shallow wells based on the IT findings. We recognize the wide variation in reported hydraulic conductivities for the area and the possible presence of preferential pathways of higher permeability in the alluvium formation. The hydraulic conductivity value used for modeling at Site 1111 was calibrated based on the observed field data, which indicate moderate biodegradation and minimum migration of CAH compounds occurring at the site. Actual PCE and TCE concentrations detected in downgradient monitoring wells drop below MCLs within 200 feet of the source area. In contrast, if an average hydraulic conductivity of 750 ft/day is used in the model, the estimated MCL plumes for PCE and TCE would be approximately 700 feet long, more than three times longer than actually observed. Regardless of the modeling uncertainties, the DON has repeatedly stated that the buried waste at Site 1111 poses a continuous source of contaminants to the underlying groundwater and must be removed as part of any groundwater remedial alternative, including natural attenuation.

**Comment 29: Subsection 4.1.4:** According to the Fourth Paragraph, "Roughly 99% of the total VOC mass is present in the vadose zone and only 1% is present of the saturated zone." The finding fails to take into consideration the fact that IR Site 1111 is located within the flood plain of the Santa Margarita River. During the rainy season the Santa Margarita River flood plain frequently is subjected to severe flooding and it is highly probable that during and following such events the water table rises and encounters VOC impacted waste. The subject finding should be augmented to state the potential adverse effect of site waste on ground water quality during seasonal flooding. Additionally, Subsection 4.1.4 should be augmented to discuss the potential for site waste to erode and be transported offsite by surface water flow during such events.

**Response:** The VOC mass calculations presented in Subsection 3.1.4 are based on actual historical concentrations detected in soil and groundwater samples at Site 1111. These calculations indicate that 99% of the total VOC mass was detected in unsaturated soil samples from the top 6 feet bgs. Based on the historical data, groundwater elevations at the site range between 5 and 12 feet bgs. Water levels measured in site wells between 1998 and 2003 show a seasonal fluctuation in water levels of about 4 feet with the shallowest depth to groundwater during this period measured at 5.88 feet below the top of the well casing. Thus, the available data suggests that the majority of the VOC mass is present in the unsaturated soil above recent historical water levels. As stated in Response to Comment 28, the DON concurs with the Board that the buried waste at Site 1111 represents a continuous threat to groundwater. As stated in the FS, "If current conditions do not change (i.e. no soil removal action in the source area), the burn layer would provide an on-going source of VOCs to groundwater, and the CAH plume would be expected to remain at a steady state for a long time."

**Comment 30: Subsection 4.1.6:** The ecological risk assessment addresses plants, terrestrial invertebrates, mammals, and birds. Based on site conditions, the propensity for the site to be subjected to severe seasonal flooding, and the proximity of surface waters, refer to comment regarding FS Subsection 4.1.4 above, it is unclear why aquatic

life is not included in the risk assessment. Additionally, a leachability investigation conducted during the remedial investigation (Parsons, 2004), indicate there is a potential for site waste to leach pollutants at concentrations that exceed established water quality goals that are protective of freshwater aquatic life (Regional Board, Central Valley Region, 2005). Please provide the rationale for not including aquatic life in the ecological risk assessment. The discussion should address the matter from a site waste erosion and offsite transport by surface waters, and site waste leaching and offsite transport of site related pollutants by ground water.

**Response:** The affected area of Site 1111 does not contain aquatic habitat. As Comment 30 indicates, the area is subject to seasonal flooding. Conditions of seasonal flooding would lead to dilution of any site-related chemicals. These conditions do not constitute a plausible chemical threat to ecological receptors.

Potential leaching of site-related soil constituents at concentrations greater than those protective of aquatic life was addressed in the response to Comment 25. A few inorganic chemicals measured recently in undiluted groundwater are present at concentrations greater than chronic-exposure benchmarks for aquatic life in surface waters. However, there are no complete pathways and no significant ecological hazards for exposure of aquatic organisms to the undiluted groundwater below Site 1111. The chemicals in groundwater were not chemicals of potential concern for those organisms in direct contact with the contaminated soils (as documented in the Tier-1 and Tier-2 ecological risk assessments) and are not relatable to ecological hazards at the site. Also, several of the surface-water benchmarks do not have regulatory standing; they are derived, conservative values intended for screening purposes and not as indicators of expressed adverse ecological effects. The removal of the contamination source means that groundwater conditions will only improve, as described in the document.

**Comment 31: Subsection 4.4.5:** Please rectify the discrepancy between the information presented in this Subsection and that illustrated in Figure 4-3 regarding backfilling as a Land Disposal Remedial Technology option. According to Subsection 4.4.5 backfilling is not identified, yet according to Figure 4-3 backfilling is considered potentially applicable option.

**Response:** Figure 3-3 has been revised to delete backfilling as a potential applicable option.

**Comment 32: Subsection 4.5.2:** The effectiveness rating of low to moderate for institutional controls seems excessive. Based on site conditions and proximity of surface water bodies, a rating of low for effectiveness seems more appropriate for institutional controls.

**Response:** The text has been revised accordingly.

**Comment 33: Subsection 4.6.2.3:** According to the fourth paragraph remedial alternative 1111-S3 involves the collection and analysis of one confirmation soil sample for each 20- by 20-foot area of the excavation area. Please provide the rationale and/or cite the reference for the guidance document that supports the proposed sampling activities.

**Response:** The proposed confirmation sampling program was determined to be statistically appropriate to achieve a sufficient level of confidence for the purpose of risk assessment.

Based on an estimated excavation area of 80 ft x 40 ft (approximately 3200 square feet), eight samples would be collected from the bottom of the excavation using a 20 ft x 20 ft sampling grid (i.e., 400 square feet exposure area). These samples would be supplemented by another 10 to 12 samples collected from the excavation sidewalls or slopes using the same 400 square feet exposure area for a total of 20 confirmation samples. The proposed confirmation sampling program was determined to be statistically appropriate to achieve a sufficient level of confidence for the purpose of risk assessment. As an example, USEPA's (1996) Soil Screening Guidance: User's Guide (EPA/540/R-96/018), Exhibit 7, indicates that as few as 6 samples are reasonable for purposes of risk assessment assuming an exposure area of 0.5 acre. Furthermore, the soil screening guidance suggests that an exposure area of 1,000 square feet is appropriate for averaging representative soil concentrations for assessing potential risk/hazards under an unrestricted residential land use scenario, which has 2.5 times less sampling density than the proposed confirmation sampling for Site 1111.

**Comment 34: Subsection 4.6.3.3:** Please augment the discussion of the Long-Term Effectiveness and Permanence of Remedial Alternatives 1111-S1 and 1111-S2 to include the conclusion that site waste is a long-term, significant, and continuous source of pollutants to water quality that may limit the Base's ability in the future to access and/or develop water resources in the vicinity and down gradient of IR Site 1111.

**Response:** The text has been revised accordingly.

**Comment 35: Subsection 4.6.3.4:** The description of the Remedial Alternative 1111-S3 seems to contradict that presented in Table 4-2. According to Subsection 4.6.3.4, treatment is not a component of Remedial Alternative 1111-S3, yet according to Table 4-2 chemical fixation/solidification is noted. Please either correct or provide clarification regarding this apparent discrepancy, whichever is appropriate. Please note the discussion of Remedial Alternative 1111-S3 cost, presented in Subsection 4.6.3.7, includes treatment as a component of this remedial alternative.

**Response:** Table 3-2 has been revised for consistency.

**Comment 36: Subsection 4.7.8:** According to Subsection 4.7.8, the implementation of institutional controls (Remedial Alternative 1111-S2) at IR Site 1111 would be protective of human health. The argument fails to take into consideration the findings of a leachability investigation and ground water monitoring activities that indicate site waste poses a significant threat to humans that use ground water from the area for municipal and domestic purposes, refer to FS Subsection 4.1.5.

**Response:** The text has been revised to include the concept that use restriction would also need to apply to groundwater.

**Comment 37: Subsection 4.10.2.2:** Please augment the Well Head Treatment remedial technology description to specifically identify the proposed ground water

extraction location(s) within the lower Santa Margarita River Basin and the proposed reservoir where treated ground water will be discharged and stored.

**Response:** This technology was identified as a potential fail-safe contingency option in case it became necessary to treat groundwater at the extraction point in order to continue using a production well that has been impacted by a contaminant. This situation is hypothetical since no production wells have been impacted at Site 1111. The technology was not selected as a remedial option because it is not cost-effective.

**Comment 38: Subsection 4.10.4.1:** According to the ninth sentence, aquifer characteristics are one of the factors that substantiate the determination that extraction wells are an impractical remedial technology at IR Site 1111.

Please specifically identify the referenced aquifer characteristics. Additionally, note that the referenced sentence seems to contradict information presented in the eighth sentence that states the technology is suitable due to high permeability of the aquifer. Based on site conditions, proximity of a Base production well, and the limited plume size, it seems the implementation of this technology in the vicinity of and immediately down gradient of the source zone following waste/source removal (RA 1111-S3) may be effective, have financial benefits with regards to required future short- and long-term ground water monitoring activities, and warrants further consideration.

**Response:** Our review of the ninth sentence in Subsection 3.10.4.1 indicates the text states the opposite of what the comment suggests. Subsection 3.10.4.1 clearly states that while extraction wells may be considered technically feasible to implement based on the high permeability of the aquifer, this technology option is not practical due to very low levels of VOCs present in groundwater at the site. Groundwater extraction followed by ex-situ treatment is not considered cost-effective and was not retained for Site 1111 because of 1) the potentially long time necessary to achieve the remediation goal due to the inability of groundwater pumping systems to remove residual saturation of contaminant in the soil pores, and 2) the large volumes of water that need to be extracted, treated, and disposed off to remove the contaminants.

**Comment 39: Subsection 4.10.4.2:** According to the discussion in Subsection 4.10.4.2, the well point technology is not an effective remedial technology at IR Site 1111 due in part to the widespread nature of the pollutant plume. Please augment the discussion to include implementation of this technology in the vicinity of and immediately down gradient of the source zone. Following implementation of waste removal (RA 1111-S3), such an approach may be effective, have financial benefits with regards to required future short- and long-term ground water monitoring activities, and warrants further consideration.

**Response:** As discussed in the previous comment, groundwater extraction followed by ex-situ treatment is not considered cost-effective due to the potentially long time necessary to achieve the remediation goal and the large volumes of water that need to be extracted, treated, and disposed off to remove the contaminants. Based on ample experience with pump and treat at many IR Sites, the DON policy is to not pump and treat unless there is an overwhelming reason to do so.

**Comment 40: Subsection 4.10.5.1:** Based on the discussion presented in Subsection 4.10.5.1, it seems that the On-Base Surface Discharge Process Option in Figure 4-5 should be shaded to indicate the option was screened out during the initial screening process, which currently is not the case.

> **Response:** Figure 3-5 has been revised to shade the On-Base Surface Discharge without Treatment process option and correct this discrepancy.

**Comment 41: Subsection 4.10.7.1.3:** Augment Subsection 4.10.7.1.3 to include a discussion as to why dialysis and reverse osmosis are not appropriate for removing VOCs from IR Site 1111 ground water.

> **Response:** The term "dialysis" is a typographical error and has been replaced with the correct term "distillation." In addition to the inefficiencies of pump and treat, both distillation and reverse osmosis were screened out as process options because they are O&M and capital intensive, and may require multiple staging to achieve the desired goals, which may further increase costs. Subsection 3.10.7.1.3 has been revised accordingly.

**Comment 42: Subsection 4.11.6.2:** According to Subsection 4.11.6.2, a detrimental aspect of the phytoremediation process option is the introduction of non-native species. Please augment Subsection 4.11.6.2 to provide the rationale as to why the introduction of non-native species is required and the introduction of native species is not considered. The use of native species to phytoremediate contaminants may have numerous significant beneficial aspects and should be considered, if effective.

> **Response:** It is acknowledged that native plant species could be used as part of a phytoremediation remedial alternative at the site. As stated in Subsection 3.11.6.2, the existing site vegetation may already be contributing to maintaining stable plume. While phytoremediation was retained as a viable option during the technology screening and process option evaluations, the main reason it was not included as a process option in the proposed remedial alternatives for Site 1111 is because of the high level of uncertainty regarding its effectiveness and ability to meet the RAOs when compared to the other remedial alternatives retained for alternative development, including source removal.

**Comment 43: Subsection 4.12.2.2:** The description of Remedial Alternative 1111-G2 (Institutional Controls and Long-Term Groundwater Monitoring) should be augmented to include restrictions on the installation of ground water production wells in the vicinity and down gradient of IR Site 1111 in the future. Additionally, any proposal to increase ground water extraction rates from existing Base production wells in the vicinity of IR Site 1111 will have to be carefully and thoroughly reviewed. If such a proposal is approved by the regulatory agencies, enhanced ground water monitoring activities will be required at IR Site 1111 to ensure site conditions are protective of human health and the environment.

> **Response:** The text has been revised to include the points raised.

**Comment 44: Subsection 4.12.3:** Discussions of the nine National Contingency Plan (NCP) criteria for Remedial Alternative 1111-G3 should be augmented to include the multiple beneficial aspects of the inclusion of Remedial Alternative 1111-S3 (source

removal) in this remedial alternative. Additionally, the rating of the nine NCP criteria for Remedial Alternative 1111-G3 does not accurately reflect the benefits of this alternative. As an example, Remedial Alternative 1111-G2 (Institutional Controls and Long-Term Groundwater Monitoring) and 1111-G3 (Monitored Natural Attenuation, Institutional Controls, Long-Term Groundwater Monitoring, and 1111-S3) are both rated as moderate for the Long-Term Effectiveness and Permanence criterion, which seems inappropriate. It seems that Remedial Alternative 1111-G3 warrants a High rating for Long-Term Effectiveness and Permanence relative to Remedial Alternative 1111-G2. Please review the nine NCP criteria rating to ensure the existing and potential, short- and long-term disadvantageous and advantages of each remedial alternative are accurately reflected in the evaluations and ratings.

**Response:** In response to USEPA Comment 28, the Alternative 1111-G2 has been revised to include soil removal; the NCP criteria ratings have been adjusted accordingly.

**Comment 45: Subsection 4.12.3.3:** The discussion of the Long-Term Effectiveness and Permanence of Remedial Alternatives 1111-G1 and 1111-G2 should be augmented to include the fact that implementation of these remedial alternatives may have adverse consequences should the ground water resources in the vicinity and down gradient of IR Site 1111 be needed to meet the Base's current and future water requirements.

**Response:** The text has been revised for 1111-G1; for 1111-G2, please see response to Comment 44.

**Comment 46: Subsection 4.12.3.6:** According to the description of the implementability of Alternative 1111-G2, Base Environmental Security Office staff will coordinate all on-Base construction activities. Base Environmental Security Office staff should work closely with Base water resources staff to ensure proposed modifications to ground water extraction rates from production wells in the vicinity of and down gradient of IR Site 1111 does not exacerbate site conditions and/or have adverse consequences.

**Response:** Text has been added to the cited section to note that Base Environmental Security will work closely with Base water resources staff to ensure that any modifications to groundwater extraction rates from production wells in the vicinity of and downgradient of Site 1111 does not affect site conditions.

**Comment 47: Subsection 4.13.5:** According to Subsection 4.13.5, Remedial Alternative 1111-G4 has a short-term effectiveness disadvantage related to fugitive dust emissions during construction activities. It seems Remedial Alternative 1111-G4 has the same short-term effectiveness disadvantage but is not described in Subsection 4.13.5.

**Response:** The subject sentence has been deleted for clarity.

**Comment 48: Appendix A:** According to Subsection A2.1.1, benzene, 1,2-DCA, and PCE are the only pollutants that have been encountered in ground water at IR Site 1111 at concentrations that exceed maximum contaminant levels (MCLs). Historical ground water analytical results indicate 1,1,2,2-PCA, TCE, and cis 1,2-DCE were detected at concentrations that exceed MCLs and hence should be considered as ground water ARARs (Parsons, 1999).

# APPENDIX A
# APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

# Section A1
# INTRODUCTION

This appendix identifies and evaluates potential federal and state of California applicable or relevant and appropriate requirements (ARARs) from the universe of regulations, requirements, and guidance and sets forth the Department of the Navy (DON) determinations regarding those potential ARARs for each response action alternative retained for detailed analysis in this feasibility study (FS) report.

This evaluation includes an initial determination of whether the potential ARARs actually qualify as ARARs, and a comparison for stringency between the federal and state regulations to identify the controlling ARARs. The identification of ARARs is an iterative process. The final determination of ARARs will be made by the DON in the record of decision (ROD) or action memorandum (AM), after public review, as part of the response action selection process.

## A1.1 SUMMARY OF CERCLA AND NCP REQUIREMENTS

Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, 42 *United States Code* [USC.] Section [§] 9621[d]), as amended, states that remedial actions on CERCLA sites must attain (or the decision document must justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. The requirement is applicable if the jurisdictional prerequisites of the standard show a direct correspondence when objectively compared to the conditions at the site. An applicable federal requirement is an ARAR. An applicable state requirement is an ARAR only if it is more stringent than federal ARARs.

If the requirement is not legally applicable, then the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations similar to the circumstances of the proposed response action and are well suited to the conditions of the site (USEPA, 1988a). A requirement must be determined to be both relevant <u>and</u> appropriate in order to be considered an ARAR.

The criteria for determining relevance and appropriateness are listed in 40 CFR § 300.400(g)(2) and include the following:

- the purpose of the requirement and the purpose of the CERCLA action;
- the medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site;
- the substances regulated by the requirement and the substances found at the CERCLA site;

- the actions or activities regulated by the requirement and the response action contemplated at the CERCLA site;
- any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site;
- the type of place regulated and the type of place affected by the release or CERCLA action;
- the type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action; and
- any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resources at the CERCLA site.

According to CERCLA ARARs guidance (USEPA 1988a), a requirement may be "applicable" or "relevant and appropriate," but not both. Identification of ARARs must be done on a site-specific basis and involve a two-part analysis: first, a determination whether a given requirement is applicable; then, if it is not applicable, a determination whether it is nevertheless both relevant and appropriate. It is important to explain that some regulations may be applicable or, if not applicable, may still be relevant and appropriate. When the analysis determines that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable (USEPA, 1988a).

Tables included in this appendix present each potential ARAR with an initial determination of ARAR status (i.e., applicable, relevant and appropriate, or not an ARAR). For the determination of relevance and appropriateness, the pertinent criteria were examined to determine whether the requirements addressed problems or situations sufficiently similar to the circumstances of the release or response action contemplated, and whether the requirement was well suited to the site. A negative determination of relevance and appropriateness indicates that the requirement did not meet the pertinent criteria. Negative determinations are documented in the tables of this appendix and are discussed in the text only for specific cases.

To qualify as a state ARAR under CERCLA and the NCP, a state requirement must be:

- a state law or regulation,
- an environmental or facility siting law or regulation,
- promulgated (of general applicability and legally enforceable),
- substantive (not procedural or administrative),
- more stringent than federal requirements,
- identified in a timely manner, and
- consistently applied.

To constitute an ARAR, a requirement must be substantive. Therefore, only the substantive provisions of requirements identified as ARARs in this analysis are considered to be ARARs. Permits are considered to be procedural or administrative

requirements. Provisions of generally relevant federal and state statutes and regulations that were determined to be procedural or nonenvironmental, including permit requirements, are not considered to be ARARs. CERCLA Section 121(e)(1), 42 U.S.C. § 9621(e)(1), states that "No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely on-site, where such remedial action is selected and carried out in compliance with this section." The term *on-site* is defined for purposes of this ARARs discussion as "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action" (40 CFR § 300.5).

Nonpromulgated advisories or guidance issued by federal or state governments are not legally binding and do not have the status of ARARs. Such requirements may, however, be useful, and are "to be considered" (TBC). TBC (40 CFR § 300.400[g][3]) requirements complement ARARs but do not override them. They are useful for guiding decisions regarding cleanup levels or methodologies when regulatory standards are not available.

Pursuant to USEPA guidance (USEPA 1988a), ARARs are generally divided into three categories: chemical-specific, location-specific, and action-specific requirements. This classification was developed to aid in the identification of ARARs; some ARARs do not fall precisely into one group or another. ARARs are identified on a site basis for remedial actions where CERCLA authority is the basis for cleanup.

As the lead federal agency, the DON has primary responsibility for identifying federal ARARs for OU 5. Potential federal ARARs that have been identified for OU 5 are discussed in Section A1.2.2. Pursuant to the definition of the term on-site in 40 CFR § 300.5, the on-station areas that are part of this action include the contaminated soils at Sites 1A-1 and 1111 and the groundwater plumes at Sites 1111 and 12 Area, Site 13.

Identification of potential state ARARs was initiated through DON requests that the California Environmental Protection Agency (Cal/EPA) Department of Toxic Substances Control (DTSC) identify potential state ARARs, an action described in more detail in Section A1.2.3. Potential state ARARs that have been identified for OU 5 are discussed below.

## A1.2 METHODOLOGY DESCRIPTION

The process of identifying and evaluating potential federal and state ARARs is described in this subsection.

### A1.2.1 General

As the lead federal agency, the DON has primary responsibility for identification of potential ARARs for OU 5. In preparing this ARARs analysis, the DON undertook the following measures, consistent with CERCLA and the NCP:

- identified federal ARARs for each response action alternative addressed in the FS, taking into account site-specific information for OU 5 sites;

- reviewed potential state ARARs identified by the state to determine whether they satisfy CERCLA and NCP criteria that must be met in order to constitute state ARARs;
- evaluated and compared federal ARARs and their state counterparts to determine whether state ARARs are more stringent than the federal ARARs or are in addition to the federally required actions; and
- reached a conclusion as to which federal and state ARARs are the most stringent and/or "controlling" ARARs for each alternative.

## A1.2.2 Identifying and Evaluating Federal ARARs

The DON is responsible for identifying federal ARARs as the lead federal agency under CERCLA and the NCP. The final determination of federal ARARs will be made when the DON issues the ROD/AM. The federal government implements a number of federal environmental statutes that are the source of potential federal ARARs, either in the form of the statutes or regulations promulgated there under. Examples include the Resource Conservation and Recovery Act (RCRA), the Clean Water Act, the Safe Drinking Water Act, the Toxic Substances Control Act, and their implementing regulations to name a few. See NCP preamble at 55 Federal Register 8764–8765 (1990) for a more complete listing.

The proposed response action and alternatives were reviewed against all potential federal ARARs, including but not limited to those set forth at 55 Federal Register 8764–8765 (1990), in order to determine if they were applicable or relevant and appropriate utilizing the CERCLA and NCP criteria and procedures for ARARs identification by lead federal agencies.

## A1.2.3 Identifying and Evaluating State ARARs

The process of identifying and evaluating potential state ARARs by the state and the DON is described in this subsection.

As stated in Section A1.1, a state requirement must be a state environmental or facility siting law, substantive, promulgated, of general applicability, identified in a timely manner, and consistently applied in order to qualify as a potential state ARAR. A state requirement must be applicable or relevant and appropriate in accordance with 40 CFR § 300.400(g)(2) as described in Section A1.1. After a state requirement meets all the above conditions, it must be compared with federal ARARs for stringency. If the state requirement is not more stringent than a federal ARAR, it does not qualify as an ARAR.

Chapter 7 of CERCLA Compliance With Other Laws Manual: Part II (USEPA 1989a) is titled CERCLA Compliance With State Requirements. The eligibility for a state requirement to be a state ARAR is detailed in the guidance. The guidance includes a procedure for stringency comparison and the process for determining state ARARs.

Requirements may be submitted by the Regional Water Quality Control Boards (RWQCBs), the DTSC, Air Quality Management Districts (AQMDs), or other local agencies. Only ARARs identified by the state should be included in the ARARs analysis. CERCLA Section 121(d) does not require CERCLA actions to comply with local laws.

Generally, regional or local requirements that do not have general applicability do not qualify as ARARs. However, in the case of certain requirements of RWQCBs and AQMDs, requirements that are developed by a local or regional body and are adopted and legally enforceable by the state may be potential state ARARs. These requirements may include state standards that are set by regional boards as well as local requirements that are part of a legally enforceable state plan. The only "local" or "regional" laws or regulations that have been accepted as "state" ARARs are those that are part of the state's overall framework for administering the requirements of the Clean Water Act (CWA) and Clean Air Act (CAA). These are discussed further below.

The USEPA and Department of Defense (DoD) have generally concurred with the state of California that many of the promulgated regulations of the RWQCBs and the AQMDs/Air Pollution Control Districts (APCDs) are part of an overall state statutory scheme for implementation of federal laws. The RWQCBs have requirements that implement the CWA through their basin plans and water quality standards. The basin plans and water quality standards that were promulgated to implement the CWA and were applicable or relevant and appropriate have been considered potential state ARARs. Potential state ARARs that are promulgated locally as part of a state plan include regional discharge requirements of the California Regional Water Quality Control Plan designed to assure protection of beneficial uses of the state's waters.

### A1.2.3.1 SOLICITATION OF STATE ARARs UNDER NCP

USEPA guidance (USEPA, 1988b) recommends that the lead federal agency consult with the state when identifying state ARARs for remedial actions. In essence, the CERCLA/NCP requirements at 40 CFR § 300.515 for remedial actions provide that the lead federal agency request that the state identify chemical- and location-specific state ARARs upon completion of site characterization. The requirements also provide that the lead federal agency request identification of all categories of state ARARs (chemical-, location-, and action-specific) upon completion of identification of remedial alternatives for detailed analysis. The state must respond within 30 days of receipt of the lead federal agency requests. The remainder of this subsection documents the DON's efforts to date to identify and evaluate state ARARs.

### A1.2.3.2 CHRONOLOGY OF EFFORTS TO IDENTIFY STATE ARARs

The following chronology summarizes the DON efforts to obtain state assistance in identifying state ARARs, and the use of previously identified ARARs, for the potential response actions at MCB Camp Pendleton OU 5 sites. Key correspondence between the DON and the state agencies relating to this effort has been included in the Administrative Record (AR) for this FS.

Identification of state ARARs for the OU 5 sites (1A-1, 1111, and 12 Area, Site 13) have been directly or indirectly addressed in various documents as discussed below.

The Draft RI/FS OU 4 (dated 29 April 1999) included Site 1111. Potential State ARARs were submitted in the OU 4 RI/FS based upon past communications with the State. Alternatives for Site 1111 were as follows: No Action; IA; Source Removal, Disposal, and IA; Source Removal, Disposal, Phytoremediation, and IA; and Source Removal,

Downgradient Groundwater Extraction, Ex Situ Treatment, Disposal/Discharge, and IA. The DON received State comments on the draft OU 4 RI/FS in a letter from the DTSC August 2002. A response to agency comments was drafted and submitted on May 26, 2000. The responses were reviewed at the 36st FFA project managers meeting for MCB Camp Pendleton, held 2 August 2000.

The OU 3 RI/FS (dated 1 May 1998) included IR Site 1A. Site 1A-1 is located approximately 750 feet north-northeast of Site 1A in the 14 Area, northeast of Base Sewage Treatment Plant No. 1. The efforts made to identify State ARARs for the OU 3 sites were discussed in detail in the engineering evaluation/cost analysis (EE/CA) for Sites 3 and 6 (SWDIV, 1995). The DON felt that these previous efforts were sufficient for the OU 3 FS and the resulting potential State ARARs are generally pertinent to the remedial alternatives for the OU 3 sites. The Alternatives for Site 1A were No Action, Excavation/Removal and On-Base Disposal, and Excavation/Removal and Off-Base Disposal.

Although not for these specific sites, the state submitted a response to the request for ARARS in their comments on the OU 4 FS. These also addressed soil sites at Camp Pendleton and would therefore provide some precedent for similar soil sites in OU 5.

These previous efforts and experience in identifying State ARARs are considered sufficient for the OU 5 FS and the resulting potential State ARARs are generally pertinent to the remedial alternatives for the OU 5 sites. Any further ARARs-related comments received by the agencies on this Draft FS will be addressed and incorporated into the Draft Final FS.

## A1.3 OTHER GENERAL ISSUES

The only general issue identified during the evaluation of ARARs for OU 5 was the General Approach to Requirements of the Federal Resource Conservation and Recovery Act.

The RCRA is a federal statute passed in 1976 to meet four goals: the protection of human health and the environment, the reduction of waste, the conservation of energy and natural resources, and the elimination of the generation of hazardous waste as expeditiously as possible. The Hazardous and Solid Waste Amendments (HSWA) of 1984 significantly expanded the scope of RCRA by adding new corrective action requirements, land disposal restrictions, and technical requirements. RCRA, as amended, contains several provisions that are potential ARARs for CERCLA sites.

Substantive RCRA requirements are applicable to response actions on CERCLA sites if the waste is a RCRA hazardous waste, and either:

- the waste was initially treated, stored, or disposed of after the effective date of the particular RCRA requirement; or
- the activity at the CERCLA site constitutes treatment, storage, or disposal, as defined by RCRA (USEPA, 1988a).

The preamble to the NCP indicates that state regulations that are components of a federally authorized or delegated state program are generally considered federal

requirements and potential federal ARARs for the purposes of ARARs analysis (55 Federal Register 8666, 8742 [1990]). The state of California received approval for its base RCRA hazardous waste management program on 23 July 1992 (57 Federal Register 32726 [1992]). The state of California "Environmental Health Standards for the Management of Hazardous Waste," set forth in Title 22 *California Code of Regulations*, Division 4.5 (CCR Title 22, div. 4.5), were approved by USEPA as a component of the federally authorized state of California RCRA program. On 26 September 2001, California received final authorization of its revised State Hazardous Waste Management Program by the USEPA (63 Federal Register 49118 [2001]).

The regulations of CCR Title 22, div. 4.5 are, therefore, a source of potential federal ARARs for CERCLA response actions. The exception is when a state regulation is "broader in scope" than the corresponding federal RCRA regulations. In that case, such regulations are not considered part of the federally authorized program or potential federal ARARs. Instead, they are purely state law requirements and potential state ARARs.

The USEPA 23 July 1992 notice approving the state of California RCRA program (57 Federal Register 32726 [1992]) specifically indicated that the state regulations addressed certain non-RCRA, state-regulated hazardous wastes that fell outside the scope of federal RCRA requirements. CCR Title 22, div. 4.5 requirements would be potential state ARARs for such non-RCRA, state-regulated wastes.

A key threshold question for the ARARs analysis is whether or not the contaminants at OU 5 sites constitute federal hazardous waste as defined under RCRA and the state's authorized program or qualify as non-RCRA, state-regulated hazardous waste. A discussion of waste characterization is included in Section A1.4.

## A1.4 WASTE CHARACTERIZATION

Selection of ARARs involves the characterization of wastes as described below.

### A1.4.1 RCRA Hazardous Waste Determination

Federal RCRA hazardous waste determination is necessary to determine whether a waste is subject to RCRA requirements at CCR Title 22, div. 4.5 and other state requirements at CCR Title 23, div. 3, Chapter (ch.) 15. The first step in the RCRA hazardous waste characterization process is to evaluate contaminated media at the site(s) and determine whether the contaminant constitutes a "listed" RCRA waste. The preamble to the NCP states that "... it is often necessary to know the origin of the waste to determine whether it is a listed waste and that, if such documentation is lacking, the lead agency may assume it is not a listed waste" (55 Federal Register 8666, 8758 [1990]).

This approach is confirmed in USEPA guidance for CERCLA compliance with other laws (USEPA, 1988a), as follows:

"To determine whether a waste is a listed waste under RCRA, it is often necessary to know the source. However, at many Superfund sites, no information exists on the source of wastes. The lead agency should use available site information, manifests, storage records, and vouchers in an effort to ascertain the nature of these contaminants. When

this documentation is not available, the lead agency may assume that the wastes are not listed RCRA hazardous wastes, unless further analysis or information becomes available that allows the lead agency to determine that the wastes are listed RCRA hazardous wastes."

RCRA hazardous wastes that have been assigned USEPA hazardous waste numbers (or codes) are listed in CCR Title 22, §§ 66261.30–66261.33. The lists include hazardous waste codes beginning with the letters "F," "K," "P," and "U."

Knowledge of the exact source of a waste is required for source-specific listed wastes ("K" waste codes). Some knowledge of the nature or source of the waste is required even for listed wastes from nonspecific sources, such as spent solvents ("F" waste codes) or commercial chemical products ("P" and "U" waste codes). These listed RCRA hazardous wastes are restricted to commercially pure chemicals used in particular processes such as degreasing.

P and U wastes cover only unused and unmixed commercial chemical products, particularly spilled or off-spec products (USEPA, 1991a). Not every waste containing a P or U chemical is a hazardous waste. To determine whether a CERCLA investigation-derived waste contains a P or U waste, there must be direct evidence of product use. In particular, all the following criteria must be met. The chemicals must be:

- discarded (as described in 40 CFR § 261.2[a][2]),
- either off-spec commercial products or a commercially sold grade,
- not used (soil contaminated with spilled unused wastes is a P or U waste), and
- the sole active ingredient in a formulation.

Available historical information was reviewed during the RCRA Facility Assessment (RFA) and the RI. Interviews were conducted with past and current MCB Camp Pendleton staff. No documentation of past waste disposal practices was found that would serve to classify the sources of soil or groundwater contamination at the OU 5 sites with respect to the RCRA waste listings. Therefore, the DON has made the determination that OU 5 soil and groundwater do not contain potential RCRA-listed hazardous wastes. By extension of this reasoning, excavated soil or extracted groundwater would not be RCRA-listed hazardous wastes either.

The second step in the RCRA hazardous waste characterization process is to evaluate potential hazardous characteristics of the waste. The evaluation of characteristic waste is described in USEPA guidance as follows (USEPA, 1988a):

> Under certain circumstances, although no historical information exists about the waste, it may be possible to identify the waste as RCRA characteristic waste. This is important in the event that (1) remedial alternatives under consideration at the site involve on-site treatment, storage, or disposal, in which case RCRA may be triggered as discussed in this section; or (2) a remedial alternative involves off-site shipment. Since the generator (in this case, the agency or responsible party conducting the Superfund action) is responsible for determining whether the wastes exhibit any of these characteristics (defined in 40 CFR §§ 261.21–261.24), testing may be required. The lead agency must use best professional

> judgment to determine, on a site-specific basis, if testing for hazardous characteristics is necessary.
>
> In determining whether to test for the toxicity characteristic using the extraction procedures (EP) toxicity test, it may be possible to assume that certain low concentrations of waste are not toxic. For example, if the total waste concentration in soil is 20 times or less the EP toxicity concentration, the waste cannot be characteristic hazardous waste. In such a case, RCRA requirements would not be applicable. In other instances, where it appears that the substances may be characteristic hazardous waste (ignitable, corrosive, reactive, or EP toxic), testing should be performed.

Hazardous waste characteristics, as defined in 40 CFR §§ 261.21–261.24, are commonly referred to as ignitability, corrosivity, reactivity, and toxicity. California environmental health standards for the management of hazardous waste set forth in CCR Title 22, div. 4.5 were approved by USEPA as a component of the federally authorized California RCRA program. Therefore, the characterization of RCRA waste is based on the state requirements.

The characteristics of ignitability, corrosivity, reactivity, and toxicity are defined in CCR Title 22, §§ 66261.21–66261.24. According to CCR Title 22, § 66261.24(a)(1)(A), "A waste that exhibits the characteristic of toxicity pursuant to subsection (a)(1) of this section has the EPA Hazardous Waste Number specified in Table I of this section which corresponds to the toxic contaminant causing it to be hazardous." Table I assigns hazardous waste codes beginning with the letter "D" to wastes that exhibit the characteristic of toxicity; D waste codes are limited to "characteristic" hazardous wastes.

According to CCR Title 22, § 66261.10, waste characteristics can be measured by an available standardized test method or be reasonably classified by generators of waste based on their knowledge of the waste provided that the waste has already been reliably tested or if there is documentation of chemicals used.

Soil and groundwater at the OU 5 sites is not ignitable, corrosive, or reactive, as defined in CCR Title 22, § 66261.21–66261.23. This determination was based on knowledge of the nature and concentrations of contaminants.

The requirements at CCR Title 22, § 66261.24 list the toxic contaminant concentrations that determine the characteristic of toxicity. The concentration limits are in milligrams per liter (mg/L). These units are directly comparable to total concentrations in waste groundwater and surface water. For waste soils, these concentrations apply to the extract or leachate produced by the toxicity characteristic leaching procedure (TCLP).

A waste is considered hazardous if the contaminants in the wastewater or in the soil TCLP extract equal or exceed the TCLP limits. TCLP testing is required only if total contaminant concentrations in soil equal or exceed 20 times the TCLP limits because TCLP uses a 20-to-1 dilution for the extract (USEPA, 1988a).

Soil sampling results at Sites 1A-1 and 1111 have indicated concentrations of metals that exceed RCRA characteristic hazardous waste levels. If the soil were excavated, the waste soil would potentially be a RCRA characteristic hazardous waste.

Groundwater sampling results indicate that no chemicals of concern exceed the RCRA characteristic hazardous waste levels. Therefore, the groundwater could not potentially be a RCRA characteristic hazardous waste.

### A1.4.2 California-Regulated, Non-RCRA Hazardous Waste

A waste determined not to be a RCRA hazardous waste may still be considered a state-regulated non-RCRA hazardous waste. The state is broader in scope in its RCRA program in determining hazardous waste. CCR Title 22, § 66261.24(a)(2) lists the total threshold limit concentrations (TTLCs) and the soluble threshold limit concentrations (STLCs) for non-RCRA hazardous waste. The state applies its own leaching procedure, waste extraction test (WET), which uses a different acid reagent and has a different dilution factor (tenfold). There are other state requirements that may be broader in scope than federal ARARs for identifying non-RCRA wastes regulated by the state. These may be potential ARARs for wastes not covered under federal ARARs. See additional subsections of CCR Title 22, § 66261.24. A waste is considered hazardous if its total concentrations exceed the TTLCs or if the extract concentrations from the WET exceed the STLCs. A WET is required when the total concentrations exceed the STLC but are less than the TTLCs (CCR Title 22, div. 4.5, ch. 11, Appendix [app.] II [b]).

The soil sampling results at Sites 1A-1 and 1111 indicated that concentrations in soil exceed TTLC limits and 10 times the STLC limits for metals. Site 1A-1 also had concentrations of pesticides that exceeded TTLC and 10 times the STLC. Therefore, if waste soil is generated at Sites 1A-1 and 1111, it may be a non-RCRA California hazardous waste.

# Section A2
# CHEMICAL-SPECIFIC ARARs

Chemical-specific ARARs are generally health- or risk-based numerical values or methodologies applied to site-specific conditions that result in the establishment of a cleanup level. Many potential ARARs associated with particular response alternatives (such as closure or discharge) can be characterized as action-specific but include numerical values or methodologies to establish them so they fit in both categories (chemical- and action-specific). To simplify the comparison of numerical values, most action-specific requirements that include numerical values are included in this chemical-specific section and, if repeated in the action-specific section, the discussion refers back to this section.

This section presents ARARs determination conclusions addressing numerical values:

- for soil and air at Sites 1A-1 and 1111
- for groundwater at Site 1111 and 12 Area, Site 13.

Following the conclusions, there is a more detailed discussion of the ARARs. Potential federal and state chemical-specific ARARs are summarized in Tables A2-1 and A2-2, respectively, which are at the end of this section.

## A2.1 SUMMARY OF ARARs CONCLUSIONS BY MEDIUM

Groundwater, soil, surface water, and air are the environmental media potentially affected by the OU 5 response actions. The conclusions for ARARs pertaining to these media are presented in the following sections.

### A2.1.1 Groundwater ARARs Conclusions

Chemicals of concern in groundwater that potentially exceed ARARs at Site 1111 include benzene, 1,1,2,2-PCA, 1,2-DCA, *cis*-1,2-DCE, TCE, and PCE. Table A2-3 lists the groundwater chemicals of concern for Site 1111 compared to MCLs. The substantive provisions of the following requirements are the most stringent of the potential federal and state chemical-specific requirements evaluated for remediation of OU 5 groundwater at Site 1111 and 12 Area, Site 13:

- federal maximum contaminant levels (MCLs) for benzene, 1,2-DCA and PCE in potential drinking water at Site 1111 as promulgated by USEPA under the Safe Drinking Water Act (SDWA) at 40 CFR § 141.61(a) (Site 1111 ONLY)
- RCRA groundwater protection standards in CCR Title 22, § 66264.94(a)(1), (a)(3), (c), (d), and (e);
- state primary MCLs for benzene and 1,2-DCA in potential drinking water at Site 1111 at Code Regs. Title 22, § 64444 (Site 1111 ONLY);
- Water Quality Control Plan (WQCP) for the San Diego Basin: (establishes water quality objectives [WQOs], beneficial uses, waste discharge limitations); and
- State Water Resources Control Board Resolution 88-63, Sources of Drinking Water.

The RCRA groundwater protection standards at CCR Title 22, § 66264.94(a)(1), (a)(3), (c), (d), and (e) have been determined to be potential federal ARARs for the groundwater at Site 1111 and 12 Area, Site 13. Cleanup to background has been determined to NOT be technologically and economically feasible. For Site 1111, the groundwater was determined to be a potential drinking water source as listed in the Basin Plan and using the criteria set forth in SWRCB Res. 88-63. The lowest achievable levels that are technologically and economically feasible have been determined to be MCLs for Site 1111 at the point of compliance.

12 Area, Site 13 groundwater has been determined NOT to be a potential source of drinking water using federal criteria and SWRCB Res. 88-63 as incorporated into the Basin Plan. The lowest achievable levels that have been determined to be technologically and economically feasible are risk-based cleanup goals.

### A2.1.2 Surface Water ARARs Conclusions

Surface water is not applicable to Sites 1A-1, 1111, or 12 Area, Site 13. Therefore, no ARARs for surface water were identified.

### A2.1.3 Soil ARARs Conclusions

Soil ARARs were evaluated for Sites 1A-1 and 1111. The RCRA requirements at CCR Title 22, § 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100 are potential ARARs because they define RCRA hazardous waste. Based on sampling results, the concentrations of metals in the soil indicate that excavated soil could exceed characteristic hazardous waste levels.

The requirements at CCR Title 22, § 66264.94(a)(1), (a)(3), (c), (d), and (e) are potential federal ARARs for the vadose zone (i.e., the unsaturated zone contamination). These sections set concentration limits for the unsaturated zone. The contaminated soil being addressed by the OU 5 actions at Sites 1A-1 and 1111 could generate hazardous waste. Therefore, these requirements are potentially applicable for cleanup of waste generated during the remedial action such as waste generated during excavation. For other actions that do not generate waste such as the capping alternative for Site 1A-1, or institutional controls, the concentration limits may be potentially relevant and appropriate. It has been determined that cleanup of to background is not technologically and economically feasible. The lowest achievable levels that are technologically and economically feasible are risk-based levels that assure protection of human health and the environment including groundwater. These requirements are considered to be potential federal ARARs because they are part of the approved state RCRA program.

### A2.1.4 Air ARARs Conclusions

The soil excavation or moving activities proposed for Sites 1A-1 and 1111 have the potential for dust particle emissions. The San Diego Air Pollution Control District requirements, which have been approved into the State Implementation Plan (SIP), that have been determined to be chemical-specific potential federal ARARs for dust control have been identified. APCD Rule 50(d)(1) addresses discharge of any air contaminant

and is considered a potentially applicable federal ARAR for the discharge of particulate matter via fugitive dust emissions from soil excavation. Rule 50(d)(1) prohibits discharge of any air contaminant from any single source of emissions that is darker than number 1 on the Ringlemann Chart for more than 3 minutes in any 60-minute period.

## A2.2 DETAILED DISCUSSION OF ARARs BY MEDIUM

The following subsections provide a detailed discussion of federal and state ARARs by medium.

### A2.2.1 Groundwater ARARs

Potential ARARs for the groundwater at Site 1111 and 12 Area, Site 13 have been identified and evaluated in this section.

#### A2.2.1.1 FEDERAL

One of the significant issues in identifying ARARs for groundwater under the SDWA and RCRA is whether the groundwater at the site can be classified as a source of drinking water. USEPA groundwater policy is set forth in the preamble to the NCP (55 Federal Register 8666, 8752–8756 [1990]). This policy uses the groundwater classification system set forth in the draft USEPA Guidelines for Groundwater Classification Under the EPA Groundwater Protection Strategy (USEPA, 1986). Under this policy, groundwater is classified in one of three categories (Class I, II, or III), based on ecological importance, replaceability, and vulnerability considerations. Irreplaceable groundwater that is currently used by a substantial population or groundwater that supports a vital habitat is considered to be Class I. Class II consists of groundwater that is currently being used or that might be used as a source of drinking water in the future. Groundwater that cannot be used for drinking water due to insufficient quality (e.g., high salinity or widespread, naturally occurring contamination) or quantity is considered to be Class III. The USEPA guidelines define Class III groundwater as groundwater with total dissolved solids (TDS) concentrations over 10,000 mg/L and a yield of less than 150 gallons per day (USEPA, 1986). Class III groundwater can also be classified based on economic or technological treatability tests as well as quality or quantity (both criteria are not needed, just one or the other).

USEPA's position is that since California does not have a USEPA-endorsed comprehensive state groundwater protection program, the federal definition of potential drinking water (10,000 parts per million [ppm] TDS or less and a yield of 150 gallons per day) should be used during the RI/FS rather than the state definition found in SWRCB Res. 88-63. USEPA provides guidelines for applying the federal groundwater classification criteria and includes site-specific factors that can be considered in making a final determination as to whether all or portions of the aquifer(s) should be considered a potential drinking-water source. These factors include:

- the thickness of the aquifer,
- the actual groundwater yield,
- the proximity to salt water and the potential for saltwater intrusion,

- the quality of underlying water-bearing units and whether these units are current or potential drinking-water sources,
- the existence of institutional controls on well construction or aquifer use,
- information on current or historical use of the aquifer, and
- the cost of cleanup to MCLs.

At Site 1111, the groundwater is considered a potential drinking water source in EPA groundwater Class I or II.

For 12 Area, Site 13, the average TDS value based on geochemical results from all the 18 shallow wells sampled in January 2002 and March 2003 is approximately 6,172 mg/L with a minimum and maximum of 2,040 and 10,800 mg/L, respectively. The average TDS value based on geochemical data from 12 deep wells sampled in January 2002 and March 2003 is approximately 9,688 mg/L, with a minimum and maximum of 4,550 and 12,000 mg/L, respectively. No yield data are available for this site. Therefore, the groundwater at Site 13 may be Class II unless yield data result in less than 150 gallons per day. However, even though the groundwater may fit in the U. S. EPA Class II, it is not a potential drinking water source based on the following. The site has not used and is not currently using the groundwater because the TDS is very high and it does not meet the State criteria for a potential drinking water source. The site has not historically pumped groundwater and there is no need since the area is supplied by water from the Santa Margarita River.

### *Safe Drinking Water Act*

Federal MCLs and MCLGs developed by USEPA under the SDWA are potential relevant and appropriate requirements for aquifers with Class I and Class II characteristics. The POC for MCLGs and MCLs under the SDWA is at the tap. Therefore, the MCLs and MCLGs are not "applicable" ARARs for DON sites. However, MCLs and MCLGs are generally considered relevant and appropriate as remediation goals for current or potential drinking water sources, and thus are commonly identified as potential ARARs for groundwater response actions under CERCLA where drinking water sources are addressed.

For aquifers with Class III characteristics, drinking water standards (MCLs, MCLGs, secondary MCLs) are neither applicable nor relevant and appropriate (USEPA, 1986; 55 Fed. Reg. 8666, 8750–8754 [1990]). Similarly, for Class II aquifers that are not determined to be potential drinking water sources, drinking water standards are not potential ARARs. Therefore, drinking water standards are not potential ARARs for 12 Area, Site 13.

Site 1111 groundwater is considered a potential drinking water source. The chemicals of concern that potentially exceed MCLs at Site 1111 are benzene, 1,2-DCA and PCE. Therefore, the federal MCLs at 40 CFR § 141.61(a) for benzene, 1,2-DCA and PCE are potential relevant and appropriate requirements. Since there are MCLs for the chemicals of concern, the MCLGs are not potential ARARs. See Table A2-3 for a comparison of maximum concentrations in groundwater at Site 1111 and the federal MCLs.

### *RCRA Hazardous Waste*

The federal RCRA requirements at 40 CFR pt. 261 do not apply in California because the state RCRA program is authorized. The authorized state RCRA requirements are therefore considered potential federal ARARs (see Section A1.3.1). The applicability of RCRA requirements depends on whether the waste is a RCRA hazardous waste, whether the waste was initially treated, stored, or disposed of after the effective date of the particular RCRA requirement, and whether the activity at the site constitutes treatment, storage, or disposal as defined by RCRA. However, RCRA requirements may be relevant and appropriate even if they are not applicable. Examples include activities that are similar to the definition of RCRA treatment, storage, or disposal for waste that is similar to RCRA hazardous waste.

The determination of whether a waste is a RCRA hazardous waste can be made by comparing the site waste to the definition of RCRA hazardous waste. The RCRA requirements at CCR Title 22, § 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100 are potential ARARs because they define RCRA hazardous waste. A waste can meet the definition of hazardous waste if it has the toxicity characteristic of hazardous waste. This determination is made by using the toxicity characteristic leaching procedure (TCLP). The maximum concentrations allowable for the TCLP listed in § 66261.24(a)(1)(B) are potential federal ARARs for determining whether the site has hazardous waste. If the site waste has concentrations exceeding these values, it is determined to be a characteristic RCRA hazardous waste (see Section A1.4.1).

Maximum groundwater concentrations at Site 1111 and 12 Area, Site 13 were compared to the TCLP limits. Maximum concentrations were not within an order of magnitude of the TCLP levels. Therefore the groundwater is not a potentially hazardous waste. However, since the detected constituents were the same as RCRA constituents and remedial action is proposed that is similar to a RCRA action, the RCRA groundwater protection standards were evaluated for the potential to be relevant and appropriate requirements.

### *RCRA Groundwater Protection Standards*

Groundwater concentration limits for RCRA-regulated units are promulgated at CCR Title 22, § 66264.94. For corrective action programs, CCR Title 22, § 66264.94(c) states that the concentrations of compounds must not exceed the background level of that constituent in groundwater or, if achieving background is shown to be technologically or economically infeasible, some higher concentration limit that is set as part of the corrective action program.

These standards are not "applicable" because OU 5 sites do not contain RCRA waste management units. However, for actions that do not generate a potentially hazardous waste, these requirements are potentially relevant and appropriate.

Substantive provisions of CCR Title 22, § 66264.94(a)(1), (a)(3), (c), (d), and (e) are "relevant and appropriate" federal ARARs for groundwater at Site 1111 and 12 Area, Site 13 because the constituents in the groundwater or soil at the sites are similar or identical to RCRA hazardous wastes.

The DON has evaluated the technical and economic feasibility of cleanup of groundwater to background for Site 1111 and determined that it is not technically or economically feasible to clean up to background. The lowest level of cleanup that is technically and economically feasible to achieve is the MCL. Further remediation beyond MCL is determined not to be economically feasible. The cost for monitoring and other active remediation to reach those levels is not determined to be economically feasible. However, it is recognized that background levels will most likely be met over time.

The DON has evaluated the technical and economic feasibility of cleanup of groundwater to background for 12 Area, Site 13 and determined that it is not technically or economically feasible to clean up to background. Since the groundwater at 12 Area, Site 13 is not a potential source of drinking water, MCLs have been determined not to be potential ARARs. The lowest concentration demonstrated to be technologically and economically achievable is a potential ARAR for the groundwater at these sites. In general, economic feasibility is an objective balancing of the incremental benefit of attaining further reductions in the concentrations of constituents of concern as compared with the incremental cost of achieving those reductions. Since the groundwater at 12 Area, Site 13 is not a drinking water source, there is not a benefit of attaining further reduction than required for being protective of human health and environment. Therefore, the lowest feasible concentration limits are based on the site risk. Further remediation beyond risk-based levels is determined not to be economically feasible. The cost for monitoring and other active remediation to reach those levels is not determined to be economically feasible. However, it is recognized that background levels will most likely be met over time.

The RCRA groundwater protection standard provisions of CCR Title 22, § 66264.95 indicate that the POC at which the protection standards apply is a vertical surface located at the hydraulically downgradient limit of the waste management area that extends through the uppermost aquifer underlying the regulated unit

The CERCLA NCP preamble provides that compliance with groundwater cleanup standards should be attained throughout the affected area of the aquifer or at and beyond the downgradient edge of the waste management area (WMA) when the waste is left in place (the "point of compliance"). See NCP preamble at 55 Federal Register 8753, 08 March 1990. CCR Title 22, § 66264.95 contains similar provisions for "point of compliance" for waste management units (WMUs) regulated under CCR Title 23, ch. 15.

It is the DON's position that the designation of points of compliance at the downgradient edge of all sites addressed in this FS would be appropriate and is supported by CERCLA, the NCP, and the administrative record for this FS. The remedial action objectives (RAOs) should apply throughout the contaminant plume downgradient from the points of compliance. The RAOs for groundwater cleanup are federal MCLs for Site 1111 and risk based concentrations for 12 Area, Site 13. The DON believes that contamination upgradient of the points of compliance would be adequately contained by the remedial action to ensure compliance with the RAOs and that the remedial action would adequately protect human health and the environment. It is also recognized that background levels will most likely be met over time throughout the entire plume.

However, that is beyond the risk-based needs for these sites and is therefore determined to be not economically feasible.

The NCP preamble states that there may be certain circumstances where a plume of groundwater contamination is caused by releases from several distinct sources that are in close geographical proximity. The NCP preamble provides that, in such cases, the most cost-effective groundwater cleanup strategy may be to address the problem as a whole rather than on a source-by-source basis, and to draw a common "point of compliance" that encompasses all the sources of release (55 Federal Register 8753, 08 March 1990).

### *CERCLA Alternative Concentration Levels*

Under CERCLA Section 121(d)(2)(B)(ii) (42 U.S.C. § 9621[d][2][B][ii]), an alternative concentration limit (ACL) using a point of exposure (akin to a POC) beyond the facility boundary can be used where:

- there are known and projected points of entry of such groundwater into surface water,
- there will be no statistically significant increase of hazardous constituents from groundwater in surface water at the point of entry or at any point where there is reason to believe accumulation of constituents may occur downstream, and
- there are enforceable institutional controls to preclude human exposure at any point between the facility boundary and the point of entry into surface water.

There is no known discharge of groundwater to surface water in the vicinity of Sites 1A-1, 1111 and 12 Area, Site 13. Therefore, exposure-based CERCLA ACLs are not considered to be ARARs for these sites

### *National Ambient Water Quality Criteria*

Section 304(a)(1) of the Clean Water Act (CWA) (33 U.S.C. § 1314[a][1]) directs USEPA to publish and periodically update the National Ambient Water Quality Criteria (NAWQC). These standards are intended to protect human health and aquatic life from contamination in surface water. The NAWQC are updated in the Federal Register. The latest list of the NAWQC through June 2000 was published in the Federal Register on 10 December 1998 with amendments in 64 Federal Register 19781 (1999). These criteria are to reflect the latest scientific knowledge on the identifiable effects of pollutants on public health and welfare, aquatic life, and recreation. These criteria serve as guidance to states in adopting water quality standards under Section 303(c) (33 U.S.C. § 1313[c]) of the CWA that protect aquatic life from acute and chronic effects.

The applicability of surface water criteria to groundwater is discussed in CERCLA Section 121(d)(2)(B)(i) (42 U.S.C. § 9621[d][2][B][i]), 40 CFR § 300.430(e), and the NCP preamble (55 Federal Register 8666, 8754–8755 [1990]). Although the NAWQC are nonenforceable guidelines, they may be potentially relevant and appropriate for groundwater determined to be a drinking water source only in the absence of promulgated MCLs or MCLGs. In such cases, the NAWQC may be adjusted to reflect only drinking water use and be used as cleanup goals for the response action. Since the groundwater at 12 Area, Site 13 is not a potential source of drinking water, the NAWQC

are not potential ARARs for those sites. Since the chemicals of concern have MCLs, the NAWQC are not potential ARARs for the OU 5 sites.

### A2.2.1.2 STATE

The state requirements evaluated for groundwater cleanup at the OU 5 Site 1111 and 12 Area, Site 13 are:

- state primary MCLs, CCR Title 22, §§ 64431;
- SWRCB Resolution (Res.) 68-16, Res. 88-63, and Res. 92-49;
- Comprehensive Water Quality Plan for the San Diego Basin (Basin Plan);
- Porter-Cologne Water Quality Control Act, Cal. Water Code §§ 13241, 13243, 13263(a), 13269, and 13360;
- CCR Title 23, div. 3, ch. 15, § 2550(a), 2550.4(d), (e), and (f), and 2550.5; and
- CCR Title 27, div. 2, subdiv. 1, § 20400(a), (c), and (e).

Section A1.2.3 includes a discussion of the identification of potential ARARs by the state.

#### *Primary State MCLs*

Primary state MCLs for organics are set forth in CCR Title 22, § 64444. The DON has determined that the substantive provisions of the standards in § 64444 for benzene and 1,2-DCA constitute potential "relevant and appropriate" state ARARs for the aquifer for chemicals of concern for Site 1111 as listed in Table A2-3. These have been identified as controlling ARARs for Site 1111 groundwater since they are more stringent than federal MCLs. The point of compliance for the MCLs is the same as that for the federal MCLs. See the discussion in Section A2.2.1.1 under RCRA Groundwater Protection Standards.

**Porter-Cologne Water Quality Control Act.** The Porter-Cologne Water Quality Control Act (Porter-Cologne Act) became Division 7 of the California Water Code in 1969. The Porter-Cologne Act requires each regional board to formulate and adopt Basin Plans for all areas within the region (Cal. Water Code § 13240). It also requires each regional board to establish WQOs that will protect the beneficial uses of the water basin (Cal. Water Code § 13241) and to prescribe waste discharge requirements that would implement the Basin Plan for any discharge of waste to the waters of the state (Cal. Water Code § 13263[a]).

Other sections of the Porter-Cologne Act include Cal. Water Code § 13243, which allows regional boards to specify conditions or areas where waste discharge is not permitted. Cal. Water Code § 13269 provides the boards authority for waivers for reports or compliance with requirements as long as it is not against the public interest. Cal. Water Code § 13360 specifies circumstances for regional boards to order compliance in a specific manner.

The DON accepts the substantive provisions of Cal. Water Code §§ 13241, 13243, 13263(a), 13269, and 13360 of the Porter-Cologne Act as enabling legislation as implemented through the beneficial uses, water quality objectives (WQOs), waste

discharge requirements, promulgated policies of the water quality control plan (WQCP) for the San Diego Region, SWRCB Res. 68-16 and Res. 88-63, and state primary MCLs as potential state ARARs. Where waste discharge requirements are specified in general permits, the substantive requirements in the permits, but not the permits themselves, are potential ARARs.

Cal. Water Code § 13304 sets forth enforcement authority and an enforcement process (orders issued by the state) and is procedural in nature. It does not constitute an ARAR because it does not itself establish or contain substantive environmental "standards, requirements, criteria, or limitations" (CERCLA Section 121 [42 U.S.C. § 9621]) and is not in itself directive in intent. Through its enforcement authority and procedures, substantive state environmental standards set forth in other statutes, regulations, plans, and orders are enforced. In addition, Cal. Water Code § 13304 is no more stringent than the substantive requirements of the potential state ARARs identified in the above paragraphs or potential federal ARARs for groundwater.

**Comprehensive Water Quality Control Plan for San Diego (Basin Plan).** The DON accepts the substantive provisions in Chapters 2 and 3 of the Basin Plan, including beneficial use and water quality objectives, as potential ARARs for the groundwater sites 1111 and 12 Area, Site 13. All three sites are within the Santa Margarita Hydrologic Unit. The beneficial uses listed for the groundwater in the hydrologic areas for the sites are:

**MUN** – Municipal and Domestic Supply

**AGR** – Agricultural Supply

**IND** – Industrial Service Supply

**PROC** – Industrial Process Supply

Based on comparison to the criteria in SWRCB Res. 88-63, the groundwater at 12 Area, Site 13 is not a potential source of drinking water. The Basin Plan states that under the Clean Water Act Section 303 regulations at 40 C.F.R. §131, "States may remove a designated beneficial use or substitute sub-categories of a use only if (a) the use is not an existing use and (b) the state can demonstrate that attaining the designated use is not feasible for one of the following reasons [40 CFR 131.10(g)]: naturally occurring pollutant concentrations prevent the attainment of the use; or natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use". The Basin Plan furthers this by incorporating the Sources of Drinking Water Policy of SWRCB Resolution No. 88-63 into the Basin Plan. This policy was used at 12 Area, Site 13 to determine whether the groundwater could be potential drinking water. Both sites lacked the quality and yield to be a potential drinking water source. The Basin Plan also states that "Designated beneficial uses are generally, but not always, present throughout the entire reach of a particular hydrologic unit, area, subarea, or water body." So, although the Basin Plan is recognized as a potential ARAR for beneficial uses, the designated beneficial use for 12 Area, Site 13 as drinking water (MUN) was not determined to be an ARAR. In fact, the quality and yield of the groundwater precludes all of the listed beneficial uses at this site. Therefore, the listed beneficial uses are not potential ARARs for 12 Area, Site 13.

Site 1111 is located close to the Santa Margarita River and it does meet the criteria for a potential source of drinking water. Therefore, the listed beneficial uses are potential applicable requirements for Site 1111 groundwater.

The Basin Plan establishes location-specific beneficial uses and WQOs for the groundwater in the Santa Margarita. The WQOs specific to the Santa Margarita Hydrologic Unit do not include the chemicals of concern at the OU 5 groundwater sites. The WQOs do include 750 mg/L TDS. The natural TDS levels for 12 Area, Site 13 exceed 750 mg/L. Since the natural groundwater at these sites does not meet the TDS water quality objective which the beneficial uses are based on, the beneficial uses for the groundwater at 12 Area, Site 13 can not be met.

The other groundwater objectives that address the chemicals of concern reiterate other regulations including MCLs for MUN, which have been evaluated for the potential drinking water source at Site 1111 above.

**State Water Resources Control Board Res. 92-49 and 68-16.**

State Water Resources Control Board Res. 92-49 (as Amended on 21 April 1994 and 02 October 1996) is titled Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Cal. Water Code § 13304. This resolution contains policies and procedures for the regional boards that apply to all investigations and cleanup and abatement activities for all types of discharges subject to Cal. Water Code § 13304.

SWRCB Res. 68-16, Statement of Policy With Respect to Maintaining High Quality of Waters in California, establishes the policy that high-quality waters of the state "shall be maintained to the maximum extent possible" consistent with the "maximum benefit to the people of the state." It provides that whenever the existing quality of water is better than the required applicable water quality policies, such existing high-quality water will be maintained until it has been demonstrated to the state that any change will be consistent with maximum benefit to the people of the state, will not unreasonably affect present and anticipated beneficial use of such water, and will not result in water quality less than that prescribed in the policies. It also states that any activity that produces or may produce a waste or increased volume or concentration of waste and that discharges or proposes to discharge to existing high-quality waters will be required to meet waste-discharge requirements that will result in the best practicable treatment or control of the discharge necessary to assure that a) pollution or a nuisance will not occur and b) the highest water quality consistent with maximum benefit to the people of the state will be maintained (SWRCB 1968).

Cleanup to below background water quality conditions is not required by the SWRCB under the Porter-Cologne Act. SWRCB Res. 92-49 II.F.1 (SWRCB 1992) provides that regional boards may require cleanup and abatement to "conform to the provisions of the Resolution No. 68-16 of the State Water Board, and the Water Quality Control Plans of the State and Regional Water Quality Control Boards, provided that under no circumstances shall these provisions be interpreted to require cleanup and abatement that achieves water quality conditions that are better than background conditions."

**DON's Position Regarding SWRCB Res. 92-49 and 68-16.**

The DON recognizes that the key substantive requirements of CCR Title 22, § 66264.94 (and the identical requirements of CCR Title 23, § 2550.4 and Section III.G of SWRCB Res. 92-49) require cleanup to background levels of constituents unless such restoration proves to be technologically or economically infeasible and an alternative cleanup level of constituents will not pose a substantial present or potential hazard to human health or the environment. In addition, the DON recognizes that these provisions are more stringent than corresponding provisions of 40 CFR § 264.94 and, although they are federally enforceable via the RCRA program authorization, they are also independently based on state law to the extent that they are more stringent than the federal regulations.

The DON has also determined that SWRCB Res. 68-16 is not a chemical-specific ARAR for determining response action goals. The DON has determined that further migration of already-contaminated groundwater is not a discharge governed by the language in Res. 68-16. More specifically, the language of SWRCB Res. 68-16 indicates that it is prospective in intent, applying to new discharges in order to maintain existing high-quality waters. It is not intended to apply to restoration of waters that are already degraded.

The DON's position is that SWRCB Res. 68-16 and 92-49 and CCR Title 23, § 2550.4 do not constitute chemical-specific ARARs for this response action because they are state requirements and are not more stringent than federal ARAR provisions of CCR Title 22, § 66264.94. The NCP set forth in 40 CFR § 300.400(g)(4) provides that only state standards more stringent than federal standards may be ARARs (see also CERCLA Section 121(d)(2)(A)(ii) [42 U.S.C. § 9621(d)(2)(A)(ii)]).

The substantive technical standard in the equivalent state requirements (i.e., CCR Title 23, div. 3, ch. 15 and SWRCB Res. 92-49 and 68-16) is identical to the substantive technical standard in CCR Title 22, § 66264.94. This section of CCR Title 22 will likely be applied in a manner consistent with equivalent provisions of other regulations, including SWRCB Res. 92-49 and 68-16.

**State of California's Position Regarding SWRCB Res. 92-49 and 68-16.**

The state does not agree with the DON determination that SWRCB Res. 92-49 and 68-16 and certain provisions CCR Title 23, div. 3, ch. 15 are not ARARs for this response action. SWRCB has interpreted the term "discharges" in the California Water Code to include the movement of waste from soils to groundwater and from contaminated to uncontaminated water (SWRCB 1994). However, the state agrees that the proposed action would comply with SWRCB Res. 92-49 and 68-16, and compliance with the CCR Title 22 provisions should result in compliance with the CCR Title 23 provisions. The state does not intend to dispute the FS, but reserves its rights if implementation of the CCR Title 22 provisions is not as stringent as state implementation of CCR Title 23 provisions. Because CCR Title 22 regulation is part of the state's authorized hazardous waste control program, it is also the state's position that CCR Title 22, § 66264.94 is a state ARAR and not a federal ARAR (United States v. State of Colorado, 990 F.2d 1565 [1993]).

Whereas the DON and the state of California have not agreed on whether SWRCB Res. 92-49 and 68-16 and CCR Title 23, § 2550.4 are ARARs for this response action, this FS documents each of the parties' positions on the resolutions but does not attempt to resolve the issue.

**State Water Resources Control Board Res. 88-63, Adoption of Policy Entitled "Sources of Drinking Water."**

SWRCB Res. 88-63 establishes criteria to help RWQCBs identify potential sources of drinking water (SWRCB 1988). According to this resolution, all groundwater in California is considered suitable or potentially suitable for domestic or municipal freshwater supply except in cases where any one of the following water quality and production criteria cannot be met.

- TDS exceed 3,000 mg/L (or electrical conductivity is greater than 5,000 micromhos per centimeter) and the RWQCB does not reasonably expect the groundwater to supply a public supply system.
- Groundwater is contaminated, either by natural processes or by human activity unrelated to a specific pollution incident, and cannot reasonably be treated for domestic use either by best management practices or best economically available treatment practices.
- The groundwater does not provide sufficient water to supply a single well capable of producing an average sustained yield of 200 gallons per day.

The DON has determined that the substantive provisions of this policy are potential state ARARs for this FS, but may not be controlling ARARs for reasons discussed below.

For 12 Area, Site 13, the average TDS value based on geochemical results from all the 18 shallow wells sampled in January 2002 and March 2003 is approximately 6,172 mg/L with a minimum and maximum of 2,040 and 10,800 mg/L, respectively. The average TDS value based on geochemical data from 12 deep wells sampled in January 2002 and March 2003 is approximately 9,688 mg/L, with a minimum and maximum of 4,550 and 12,000 mg/L, respectively. Based on these factors the groundwater at the 12 Area, Site 13 is not considered a potential source of drinking water as defined in State Resolution No. 88-63.

Site 1111 groundwater does meet the criteria of SWRCB Res. 88-63 for a potential source of drinking water.

## A2.2.2 Surface Water ARARs

Surface water is not applicable to Sites 1A-1, 1111, or 12 Area, Site 13. Therefore, no ARARs for surface water were identified.

## A2.2.3 Soil ARARs

Soil ARARs are evaluated for Sites 1A-1 and 1111. The key threshold question for soil ARARs is whether or not the soil located at Sites 1A-1 or 1111 would be classified as hazardous waste if excavated. RI data indicate concentrations in soil that exceed the

hazardous waste levels for RCRA and non-RCRA hazardous waste. If the soil is excavated, at least a portion would likely be hazardous waste.

### A2.2.3.1 FEDERAL

***RCRA Hazardous Waste and Groundwater Protection Standards***

The federal RCRA requirements at 40 CFR pt. 261 do not apply in California because the state RCRA program is authorized. The authorized state RCRA requirements are therefore considered potential federal ARARs (see Section A1.3.1). The applicability of RCRA requirements depends on whether the waste is a RCRA hazardous waste, whether the waste was initially treated, stored, or disposed after the effective date of the particular RCRA requirement, and whether the activity at the site constitutes treatment, storage, or disposal as defined by RCRA. However, RCRA requirements may be relevant and appropriate even if they are not applicable. Examples include activities that are similar to the definition of RCRA treatment, storage, or disposal for waste that is similar to RCRA hazardous waste.

The determination of whether a waste is a RCRA hazardous waste can be made by comparing the site waste to the definition of RCRA hazardous waste. The RCRA requirements at CCR Title 22, § 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100 are potential ARARs because they define RCRA hazardous waste. A waste can meet the definition of hazardous waste if it has the toxicity characteristic of hazardous waste. This determination is made by using the toxicity characteristic leaching procedure (TCLP). The maximum concentrations allowable for the TCLP listed in § 66261.24(a)(1)(B) are potential federal ARARs for determining whether the site has hazardous waste. If the site soil has concentrations exceeding these values, it would be determined to be a characteristic RCRA hazardous waste if excavated (see Section A1.4.1). Based on sampling results, the concentrations of metals in the soil indicate that excavated soil could exceed characteristic hazardous waste levels.

The requirements at CCR Title 22, § 66264.94(a)(1), (a)(3), (c), (d), and (e) are potential federal ARARs for the vadose zone (i.e., the unsaturated zone contamination). These sections set concentration limits for the unsaturated zone. The contaminated soil being addressed by the OU 5 actions at Sites 1A-1 and 1111 could generate hazardous waste. Therefore, these requirements are potentially applicable for cleanup of waste generated during the remedial action such as waste generated during excavation. For other actions that do not generate waste such as the capping alternative for Site 1A-1, or institutional controls, the concentration limits may be potentially relevant and appropriate. It has been determined that cleanup of to background is not technologically and economically feasible. The lowest achievable levels that are technologically and economically feasible are risk-based levels that assure protection of human health and the environment including groundwater. However, the remedial alternatives could result in levels lower than risk-based levels and could even result in meeting background over time. However, it has been determined that additional work to meet levels lower than risk-based levels is not economically feasible since risk levels will already be acceptable. These requirements are considered to be potential federal ARARs because they are part of the approved state RCRA program.

### A2.2.3.2 STATE

***RCRA Requirements***

State RCRA requirements included within the USEPA-authorized RCRA program for California are considered to be potential federal ARARs and are discussed above. When state regulations are either broader in scope than their federal counterparts, they are considered potential state ARARs. State requirements such as the non-RCRA, state-regulated hazardous waste requirements may be potential state ARARs because they are not within the scope of the federal ARARs (57 Federal Register 60848). The CCR Title 22, div. 4.5 requirements that are part of the state-approved RCRA program would be potential state ARARs for non-RCRA, state-regulated hazardous wastes.

The site waste characteristics need to be compared to the definition of non-RCRA, state-regulated hazardous waste. The non-RCRA, state-regulated waste definition requirements at CCR Title 22, § 66261.24(a)(2) are potential state ARARs for determining whether other RCRA requirements are potential state ARARs. This section lists the total threshold limit concentrations (TTLCs) and soluble threshold limit concentration (STLCs). The site waste may be compared to these thresholds to determine whether it meets the characteristics for a non-RCRA, state-regulated hazardous waste.

As discussed in Section A1.4, the soil sampling results at Sites 1A-1 and 1111 indicated that concentrations in soil exceed TTLC limits and 10 times the STLC limits for metals. Site 1A-1 also had concentrations of pesticides that exceeded TTLC and 10 times the STLC. Therefore, the waste may be a non-RCRA California hazardous waste.

***CCR Title 23, div. 3, ch. 15***

The requirements at this section define a hazardous waste that is covered by the Chapter 15 requirements. These are not more stringent than federal or state RCRA ARARs for identifying hazardous waste. However, if the site waste meets the definition of hazardous waste under CCR Title 23, § 2521, other Chapter 15 requirements may be ARARs for discharging waste to land including landfill requirements.

Section 2550.4 of Chapter 15 has also been identified by the state as a potential ARAR for soil cleanup levels for hazardous waste. This section is essentially the same as federal ARARs identified at CCR Title 22, § 66264.94(a)(1)(3), (c), (d), and (e). Therefore, Section 2550.4 is not an ARAR for soil cleanup levels at OU 5.

## A2.2.4 Air ARARs

There are potential emissions to air for the soil movement activities proposed for Sites 1A-1 and 1111.

### A2.2.4.1 FEDERAL

The CAA and RCRA air emission requirements are discussed below.

***Clean Air Act***

The CAA establishes the National Ambient Air Quality Standards (NAAQS) in 40 CFR § 50.4–50.12. NAAQS are not enforceable in and of themselves; they are translated into source-specific emissions limitations by the state (USEPA, 1990). Substantive requirements of the San Diego Air Pollution Control District (APCD) rules that have been approved by USEPA as part of the SIP under the CAA are potential federal ARARs for air emissions (CAA Section 110).

The SIP includes rules for emissions restrictions for particulates under San Diego APCD. APCD Rule 50(d)(1) addresses discharge of any air contaminant and is considered a potentially applicable Federal ARAR for the discharge of particulate matter via fugitive dust emissions from soil excavation. Rule 50(d)(1) prohibits discharge of any air contaminant from any single source of emissions that is darker than number 1 on the Ringlemann Chart for more than 3 minutes in any 60-minute period.

### A2.2.4.2 STATE

No State ARARs were identified for air emissions for the proposed OU 5 alternatives.

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## Table A2-1
## Potential Federal Chemical-Specific[a] ARARs by Medium

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| **GROUNDWATER (Site 1111 and 12 Area, Site 13)** | | | | |
| **Safe Drinking Water Act (42 U.S.C., ch. 6A, § 300[f]–300[j]-26)[c]** | | | | |
| National primary drinking water standards are health-based standards for public water systems (MCLs). | Public water system. | 40 C.F.R. § 141.11–141.13, excluding § 141.11(d)(3), 141.15, 141.16, 141.61(a) and (c), and 141.62(b) | Not an ARAR for 12 Area, Site 13. Relevant and appropriate for Site 1111. | 12 Area, Site 13 does not have potential drinking water sources. Not potentially applicable except at the tap. Site 1111 has a potential drinking ground water source, therefore, the MCLs are potentially relevant and appropriate requirements. |
| MCLGs pertain to known or anticipated adverse health effects (also known as recommended MCLs). | Public water system. | 40 C.F.R. § 141.50–141.51 | Not an ARAR | MCLs were available for chemicals of concern where there are potential sources of drinking water. |
| National secondary drinking water regulations are standards for the aesthetic qualities of public water systems (SMCLs). | Public water system. | 40 C.F.R. § 143.3 | Not an ARAR | SMCLs are federal contaminant levels intended as guidelines for the states. Because they are not enforceable, federal SMCLs are not ARARs. |
| **Resource Conservation and Recovery Act (42 U.S.C., ch. 82, §§ 6901–6991[i])[c]** | | | | |
| Defines RCRA hazardous waste. A solid waste is characterized as toxic, based on the TCLP, if the waste exceeds the TCLP maximum concentrations. | Waste. | Cal. Code Regs. tit. 22, § 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100 | Applicable | Applicable for determining whether waste is hazardous. |

(table continues)

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**Table A2-1** (continued)

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| Groundwater protection standards: Owners/operators of RCRA treatment, storage, or disposal facilities must comply with conditions in this section that are designed to ensure that hazardous constituents entering the groundwater from a regulated unit do not exceed the concentration limits for contaminants of concern set forth under Cal. Code Regs. tit. 22, § 66264.94 in the uppermost aquifer underlying the waste management area of concern at the POC. | A regulated unit that receives or has received hazardous waste before 26 July 1982 or regulated units that ceased receiving hazardous waste prior to 26 July 1982 where constituents in or derived from the waste may pose a threat to human health or the environment. | Cal. Code Regs. tit. 22, § 66264.94, except 66264.94(a)(2) and 66264.94(b) | Relevant and appropriate | Not potentially applicable since the sites are/were not regulated units. Potentially relevant and appropriate because some pollutants of concern are RCRA regulated parameters. Background concentrations were determined to be NOT technologically and economically feasible. The lowest achievable concentrations at 12 Area, Site 13 are risk-based concentrations. However, at Site 1111, MCLs for chemicals of concern were determined to be the lowest economically achievable concentration limits. See Section A2.2.1.1. |
| The POC is a vertical surface located at the hydraulically downgradient limit of the waste management area that extends through the uppermost aquifer underlying the regulated unit. | Hazardous waste treatment or disposal. | Cal. Code Regs. tit. 22, § 66264.95 | Relevant and appropriate | Potentially relevant and appropriate for cleanup levels for the sites. However, it is recognized that cleanup throughout the plume will occur as part of the remedial alternatives. See Section A2.2.1.1 |
| **Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S.C., ch. 103, §§ 9601–9675)[c]** | | | | |
| ACLs using a point of exposure beyond the facility boundary. | Known or projected points of entry from groundwater to surface water. | CERCLA Section 121(d)(2)(B)(ii)<br>42 U.S.C., ch. 103, § 9621 | Not an ARAR | Applicable as outlined under prerequisites. Allows a risk-based approach to setting alternative concentration limits based on a surface water discharge pathway. See Section A2.2.1.1 for more detailed discussion. Not necessary since no surface water at OU 5 Sites. |
| **Clean Water Act of 1977, as Amended (33 U.S.C., ch. 26, §§ 1251–1387)[c]** | | | | |
| National Ambient Water Quality Criteria. | Discharges to waters of the United States and groundwater. | 33 U.S.C. § 1314(a) and 42 U.S.C. § 9621(d)(2)<br>64 Fed. Reg. 19,781 (22 April 1999) | Not an ARAR | Groundwater at 12 Area, Site 13 is not a potential source of drinking water. Site 1111 groundwater chemicals of concern have MCLs and ambient water quality criteria are not necessary. |

(table continues)

**Table A2-1** (continued)

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| **SOIL (Sites 1A–1 and 1111)** | | | | |
| **Resource Conservation and Recovery Act (42 U.S.C., ch. 82, §§ 6901–6991[i])[c]** | | | | |
| Defines RCRA hazardous waste. A solid waste is characterized as toxic, based on the TCLP, if the waste exceeds the TCLP maximum concentrations. | Waste. | Cal. Code Regs. tit. 22, § 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100 | Applicable | Applicable for determining whether waste soil, if generated, is hazardous. |
| Groundwater Protection Standards: requirements to ensure that hazardous constituents entering the groundwater from a regulated unit do not exceed the concentration limits for contaminants of concern in the uppermost aquifer underlying the waste management area of concern at the POC. | A regulated unit that receives or has received hazardous waste before 26 July 1982 or regulated units that ceased receiving hazardous waste prior to 26 July 1982 where constituents in or derived from the waste may pose a threat to human health or the environment. | Cal. Code Regs. tit. 22, § 66264.94(a)(1) and (3), (c), (d), and (e) | Relevant and appropriate | Potentially relevant and appropriate for setting soil cleanup levels. Cleanup to background has been determined to be NOT technologically and economically feasible. The lowest economically achievable concentrations are risk-based. See Section A2.2.3.1. |

(table continues)

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**Table A2-1** (continued)

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| | | **AIR** | | |
| **Clean Air Act (42 U.S.C., ch. 85, §§ 7401–7671)[c]** | | | | |
| Provisions of SIP approved by U.S. EPA under Section 110 of CAA. | Major sources of air pollutants. | 42 U.S.C. § 7401; portions of 40 C.F.R. § 52.220 applicable to San Diego APCD | Applicable | See pertinent specific provisions of the SIP below. |
| No person shall discharge into the atmosphere from any single source of emissions, for more than 3 minutes in any 60-minute period, any air contaminant that is darker than number 1 on the Ringlemann chart. | Discharge of any air contaminant other than uncombined water vapor. | APCD Rule 50(d)(1) | Applicable | Potentially applicable to emissions that may be caused by soil movement and storage for Sites 1A-1 and 1111. |

(table continues)

**Table A2-1** (continued)

Notes:

[a] many potential action-specific ARARs contain chemical-specific limitations and are addressed in the action-specific ARAR tables
[b] only the substantive provisions of the requirements cited in this table are potential ARARs
[c] statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the DON accepts the entire statutes or policies as potential ARARs; specific potential ARARs are addressed in the table below each general heading; only pertinent substantive requirements of the specific citations are considered potential ARARs

Acronyms/Abbreviations:

ACL – alternative concentration limit
APCD – Air Pollution Control District
ARAR – applicable or relevant and appropriate requirement
BAT – best available technology
BCPCT – best conventional pollution control technology
CAA – Clean Air Act
Cal. Code Regs. – *California Code of Regulations*
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R. – *Code of Federal Regulations*
ch. – chapter
COC – chemical of concern
CWA – Clean Water Act
DoD – Department of Defense
DON – Department of the Navy
Fed. Reg. – *Federal Register*
LDR – land disposal restriction
MCL – maximum contaminant level
MCLG – maximum contaminant level goal
NAAQS – National Ambient Air Quality Standards (primary and secondary)
NCP – National Oil and Hazardous Substances Pollution Contingency Plan
NPDES – National Pollutant Discharge Elimination System
OU – operable unit
PCB – polychlorinated biphenyl
POC – point of compliance
ppm – parts per million
$ppm_w$ – parts per million by weight
pt. – part
R3M – Range Rule Risk Methodology
RAO – remedial action objective
RCRA – Resource Conservation and Recovery Act
RWQCB – (California) Regional Water Quality Control Board San Diego Region
§ – section
SIP – State Implementation Plan
SMCL – secondary maximum contaminant level
subpt. – subpart
TBC – to be considered
TCLP – toxicity characteristic leaching procedure
tit. – title
U.S.C. – *United States Code*
U.S. EPA – United States Environmental Protection Agency
UXO – unexploded ordnance
VOC – volatile organic compound

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**Table A2-2**
**Potential State Chemical-Specific[a] ARARs by Medium**

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| **GROUNDWATER, SURFACE WATER, SOIL, SEDIMENTS, AND AIR** | | | | |
| **Cal/EPA Department of Toxic Substances Control[c]** | | | | |
| Definition of "non-RCRA hazardous waste." | Waste. | Cal. Code Regs. tit. 22, § 66261.22(a)(3) and (4), § 66261.24(a)(2)–(a)(8), § 66261.101, § 66261.3(a)(2)(C) or § 66261.3(a)(2)(F) | Applicable | Applicable for determining whether a waste is a non-RCRA hazardous waste. |
| State MCL list. | Source of drinking water. | Cal. Code Regs. tit. 22, §64444 | Relevant and appropriate for Site 1111 Only<br>Not an ARAR for Site 1A-1 and 12 Area, Site 13 | Relevant and appropriate for benzene and 1,2-DCA in potential drinking water at Site 1111 at Code Regs. tit. 22, § 64444 (Site 1111 ONLY) |

(table continues)

**Table A2-2** (continued)

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| **State and Regional Water Quality Control Boards[c]** | | | | |
| Authorizes the SWRCB and RWQCB to establish in water quality control plans beneficial uses and numerical and narrative standards to protect both surface water and groundwater quality. Authorizes regional water boards to issue permits for discharges to land or surface or groundwater that could affect water quality, including NPDES permits, and to take enforcement action to protect water quality. | | Cal. Water Code, div. 7, §§ 13241, 13243, 13263(a), 13269, and 13360 (Porter-Cologne Water Quality Control Act) | Applicable | The DON accepts the substantive provisions of §§ 13241, 13243, 13263(a), 13269, and 13360 of the Porter-Cologne Act enabling legislation, as implemented through the beneficial uses, WQOs, waste discharge requirements, promulgated policies of the Basin Plan for the San Diego Region, as potential ARARs. |
| | | Cal. Water Code, div. 7, § 13304 | Not an ARAR | Section 13304 does not constitute an ARAR because it does not itself establish or contain substantive environmental "standards, requirements, criteria or limitations" (CERCLA Section 121) and is not in itself directive in intent. In addition, Section 13304 is not more stringent than the substantive requirements of the potential state and federal ARARs identified in this table and Table A2-1. |
| Describes the water basins in San Diego establishes beneficial uses of groundwater and surface water, establishes WQOs, including narrative and numerical standards, establishes implementation plans to meet WQOs and protect beneficial uses, and incorporates statewide water quality control plans and policies. | | Water Quality Control Plan for the San Diego Basin (Basin Plan) (Cal. Water Code § 13240) | Applicable | Substantive requirements pertaining to beneficial uses (except designated beneficial uses for 12 Area, Site 13), WQOs, and certain statewide water quality control plans are potential state ARARs for the surface water and groundwater components of this response action. |

(table continues)

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**Table A2-2** (continued)

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| Establishes the policy that high-quality waters of the state "shall be maintained to the maximum extent possible" consistent with the "maximum benefit to the people of the State." It provides that whenever the existing quality of water is better than that required by applicable water quality policies, such existing high-quality water will be maintained until it has been demonstrated to the state that any change will be consistent with maximum benefit to the people of the state, will not unreasonably affect present and anticipated beneficial use of such water, and will not result in water quality less than that prescribed in the policies. It also states that any activity that produces or may produce a waste or increased volume or concentration of waste and that discharges or proposes to discharge to existing high-quality waters will be required to meet waste-discharge requirements that will result in the best practicable treatment or control of the discharge. | | Statement of Policy With Respect to Maintaining High Quality of Waters in California, SWRCB Res. 68-16 | Not an ARAR | Not an ARAR for existing contamination or further migration of existing contaminant plumes in groundwater. No new discharges are proposed. See Section A2.2.1.2 for further discussion. |
| Describes requirements for RWQCB oversight of investigation and cleanup and abatement activities resulting from discharges of hazardous substances. RWQCB may decide on cleanup and abatement goals and objectives for the protection of water quality and beneficial uses of water within each region. Establishes criteria for "containment zones" where cleanup to established water-quality goals is not economically or technically practicable. | | Policies and procedures for investigation and cleanup and abatement of discharges under Cal. Water Code § 13304, SWRCB Res. 92-49 | Not an ARAR | Not an ARAR for groundwater cleanup if Cal. Code Regs. tit. 22, § 66264.94(c) is determined to be a federal ARAR because SWRCB Res. 92-49 is not more stringent. See Section A2.2.1.2 for more discussion. |

(table continues)

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**Table A2-2** (continued)

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| Incorporated into all regional board basin plans. Designates all groundwater and surface waters of the state as drinking water except where the TDS is greater than 3,000 ppm, the well yield is less than 200 gpd from a single well, the water is a geothermal resource or in a water conveyance facility, or the water cannot reasonably be treated for domestic use using either best management practices or best economically achievable treatment practices. | | SWRCB Res. 88-63 (Sources of Drinking Water Policy) | Applicable | Criteria used to determine whether water is a potential source of drinking-water. |
| Establishes concentration limits for cleanup actions, including groundwater, surface water, and the unsaturated zones for other than hazardous waste at background. Allows a higher cleanup limit (but not to exceed MCLs) if background is not technically or economically achievable. | | Cal. Code Regs. tit. 27, §§ 20380(a); 20400(a), (c), (d), (e), and (g) | Not an ARAR | Not more stringent than federal regulations at Cal. Code Regs. tit. 22, § 66264.94. See Section A.2.1.2 for additional discussion. |
| Establishes concentration limits for cleanup actions, including groundwater, surface water, and the unsaturated zones for hazardous waste at background. Allows a higher cleanup limit (but not to exceed MCLs) if background is not technically or economically achievable. | | Cal. Code Regs. tit. 23, §§ 2550(a); 2550.4(d), (e), and (f) | Not an ARAR | Cal. Code Regs. tit. 23, § 2550(a) addresses the general applicability of other standards in Chapter 15 and does not contain standards itself. Cal. Code Regs. tit. 23, §§ 2550.4(d), (e), and (f) are not more stringent than federal ARARs at Cal. Code Regs. tit. 22, § 66264.94. See Section A2.2.1.2 for additional discussion. |
| Definitions of designated waste, nonhazardous waste, and inert waste. | | Cal. Code Regs. tit. 27, §§ 20210, 20220, and 20230 | | Potential ARARs for classifying waste and determining ARAR status of other requirements |

(table continues)



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**Table A2-2** (continued)

Notes:

[a] many potential action-specific ARARs contain chemical-specific limitations and are addressed in the action-specific ARAR tables

[b] only the substantive provisions of the requirements cited in this table are potential ARARs

[c] statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the DON accepts the entire statutes or policies as potential ARARs; specific potential ARARs are addressed in the table below each general heading; only pertinent substantive requirements of specific citations are considered potential ARARs

Acronyms/Abbreviations:

ARAR – applicable or relevant and appropriate requirement
Cal. Code Regs. – *California Code of Regulations*
Cal/EPA – California Environmental Protection Agency
Cal. Water Code – *California Water Code*
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
div. – division
DON – Department of the Navy
gpd – gallons per day
MCL – maximum contaminant level
NPDES – National Pollutant Discharge Elimination System
OU – operable unit
ppm – parts per million
RCRA – Resource Conservation and Recovery Act
Res. – Resolution
RWQCB – (California) Regional Water Quality Control Board
§ – section
SIP – State Implementation Plan
SWRCB – (California) State Water Resources Control Board
TDS – total dissolved solids
tit. – title
WQO – water quality objective



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**Table A2-3**
**Criteria and Standards for Chemicals of Concern in Groundwater at Site 1111**
**(units reported in micrograms per liter)**

| | CONCENTRATION | | |
|---|---|---|---|
| | U.S. EPA SAFE DRINKING WATER ACT | | |
| Analyte | Maximum Contaminant Level (40 C.F.R. § 141.61(a)) | California Maximum Contaminant Level (Cal. Code Regs. tit. 22, § 64444) | Controlling ARAR Contaminant Level |
| **Volatile Organic Compounds** | | | |
| Benzene | 5 | 1 | 1 |
| 1,2-Dichloroethane | 5 | 0 5 | 0 5 |
| Tetrachloroethene | 5 | 5 | 5 |

Acronyms/Abbreviations:
ARAR – applicable or relevant and appropriate requirement
Cal. Code Regs. – *California Code of Regulations*
C F.R – *Code of Federal Regulations*
§ – section
tit. – title
U.S EPA – United States Environmental Protection Agency

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# Section A3
# LOCATION-SPECIFIC ARARs

Potential location-specific ARARs are identified and discussed in this section. The discussions are presented based on various attributes of the site location, such as whether it is within a floodplain. Additional surveys will be performed in connection with the response action design and response action to confirm location-specific ARARs where inadequate siting information currently exists, or in the event of changes to planned facility locations.

The proximity of Site 1111 to the Santa Margarita River is ecologically significant because the area supports diverse wildlife and plant species. Approximately 10 to 20 mammal species and 80 resident and migratory bird species may regularly use the site vicinity. About 8 to 10 species of amphibian and reptiles probably occur in the site vicinity, including western toad and common king snake. The adjacent riparian habitats of the Santa Margarita River support numerous endangered and threatened wildlife species, including the arroyo southwestern toad, Pacific pocket mouse, southwestern pond turtle, least Bell's vireo, and southwestern willow flycatcher (SWDIV, 1993a).

The undisturbed/unremediated portion of Site 1111 is considered arroyo southwestern toad habitat, and therefore is a sensitive ecological habitat. The ecological risk assessment identified the following federally listed species to be potentially present at Site 1111: arroyo southwestern toad (endangered), least Bell's vireo (endangered), southwestern willow flycatcher (endangered), and coastal California gnatcatcher (threatened).

Vegetation has been removed in the disturbed/remediated portion of Site 1111.

The 12 Area, Site 13 is located in the eastern portion of MCB Camp Pendleton, approximately three miles southwest of the northeastern Base entrance, and approximately 500 feet west-southwest of the intersection of Vandergrift Blvd. and 19th Street. Site 13 is currently undeveloped with the exception of a segment of paved road. The site is vegetated with low-lying grasses and several trees on the eastern portion of the site. No special-status species are known or expected to inhabit the site.

Site 1A-1 is located just north of Site 1A on the west side of Pilgrim Creek North Trails and Pilgrim Creek. The site is within the foraging area of known nesting California coastal gnatcatchers.

## A3.1 SUMMARY OF LOCATION-SPECIFIC ARARs

Cultural resources, wetlands protection, floodplain management, hydrologic resources, biological resources, and other natural resources are the resource categories relating to location-specific requirements potentially affected by the OU 5 response actions. The conclusions for ARARs pertaining to these resources are presented in the following sections.

### A3.1.1 Cultural Resources ARARs Conclusions

Substantive provisions for the identification of historical properties set forth in 36 CFR 800.3 and 800.4 are applicable Federal ARARs for excavation activities at Sites 1A-1 and 1111. Substantive provisions set forth in 36 CFR 800.5 through 800.15 and 36 CFR Part

65 are not considered ARARs for the OU 5 sites because no historical resources were identified near the sites. Substantive provisions of the Archaeological Resources Protection Act of 1979, set forth in 32 CFR 229.1 et seq., for the protection of archaeological resources on Federal lands are potential applicable Federal ARARs for excavation activities at Sites 1A-1 and 1111. These requirements will be applicable to on-site excavation if previously unidentified archaeological resources are identified during excavation activities.

### A3.1.2 Wetlands Protection and Floodplain Management Conclusions

Sites 1A-1 and 1111 are within areas susceptible to flooding during a statistical 100-year flood event. The substantive provisions of 22 CCR 66264.18(b) require that a hazardous waste facility within a 100-year floodplain be designed, constructed, operated, and maintained to avoid washout. This requirement is pertinent to Site 1111 and 1A-1 actions that may store hazardous waste. Therefore, this requirement is potentially applicable for soil actions at Sites 1A-1 and 1111 that could store hazardous waste.

Under 40 CFR § 6.302(b), federal agencies are required to evaluate the potential effects of action they may take in a floodplain to avoid, to the extent possible, adverse effects associated with direct and indirect development of a floodplain. This requirement is a potential applicable requirement for Sites 1A-1 and 1111 soil remedial activities.

### A3.1.3 Hydrologic Resources Conclusions

No hydrologic resources of concern were identified at the OU 5 sites.

### A3.1.4 Biological Resources Conclusions

No endangered species have been observed at 12 Area, Site 13. The California gnatcatcher is a federally listed endangered species and has been observed on Site 1A-1. The southwest willow flycatcher, the least Bell's vireo and the arroyo southwestern toad are federally endangered species and the California gnatcatcher is a federally listed threatened species that have been observed or their habitat is present on or near Site 1111. The requirements of the ESA at 16 U.S.C. § 1536(a), (h)(1)(B) are potentially applicable for the actions proposed at Sites 1A-1 and 1111.

Migratory birds have been observed in the vicinity of Sites 1A-1 and 1111. The substantive provisions of 16 USC 703 protects almost all species of native birds in the United States from unregulated take. This requirement is not a potential ARAR for groundwater remedial alternatives (i.e., Site 1111) because the alternatives offer no potential for a take. This requirement is potentially relevant and appropriate for the proposed excavation activities at Sites 1A-1 and 1111.

California Fish and Game Code §5650(a) and (f) prohibits the passage of enumerated substances or materials into waters of the state deleterious to fish, plant life, or birds. This has been determined to be a potential ARAR for excavation at Sites 1A-1 and 1111 where materials may be placed where they could enter surface water.

Other California Department of Fish and Game requirements were also identified as potentially relevant and appropriate requirements. These requirements are not potential ARARs for overlapping federal ARARs. The state requirements are not more stringent for the federally-protected species. However, the state requirements may be broader in scope than the federal ARARs and may address additional species. For these non-federally protected species the following are potentially relevant and appropriate requirements during proposed remedial actions: Cal. Fish and Game Code Sections §3005(a) for birds and mammals, §3503 for any bird, §3503.5 for the white-tailed kite, §3800(a) for non-game birds, §4002 for fur-bearing mammals, and §4150 for non-game mammals.

### A3.1.5 Coastal Resources Conclusions

None of the OU 5 sites is close enough to the coast to be within the coastal zone.

### A3.1.6 Geologic Characteristics Conclusions

None of OU 5 sites have any known geological characteristics that are regulated.

## *A*3.2 DETAILED DISCUSSION OF ARARs

The following subsections provide a detailed discussion of federal and state ARARs by location-specific resources. Pertinent and substantive provisions of the potential ARARs listed and described below were reviewed to determine whether they are potential federal or state ARARs for the OU 5 remedial alternatives.

Requirements that are determined to be ARARs are identified in Table A3-1 (federal) and Table A3-2 (state) at the end of this section. ARARs determinations are presented in the column denoted by the heading ARAR Determination. Determinations of status for location-specific ARARs were generally based on consultation of maps or lists included in the regulation or prepared by the administering agency. References to the document or agency consulted are provided in the Comments column and may be provided in footnotes to the table. Specific issues concerning some of the requirements are discussed in the following sections.

### A3.2.1 Cultural Resources ARARs

The following requirements were evaluated for ARARs status:

- National Historic Preservation Act of 1966, as amended (16 U.S.C. §§ 470–470x-6, 36 CFR pt. 800, 40 CFR § 6.301[b]);
- Archaeological and Historic Preservation Act (16 U.S.C. § 469–469c-1, 40 CFR § 6.301[c]);
- Historic Sites, Buildings, and Antiquities Act of 1935 (16 U.S.C. §§ 461–467, 40 CFR § 6.301[a]); and/or
- Archaeological Resources Protection Act of 1979, as amended (Pub. L. No. 96-95, 16 U.S.C. § 470aa–470mm)].

### A3.2.1.1 NATIONAL HISTORIC PRESERVATION ACT OF 1966, AS AMENDED

Pursuant to Sections 106 and 110(f) of the National Historic Preservation Act (NHPA) (16 U.S.C. §§ 470–470x-6, and its implementing regulations [36 CFR pt. 800]), as amended, CERCLA remedial actions are required to take into account the effects of remedial activities on any historic properties included on or eligible for inclusion on the National Register of Historic Places (National Register). The National Register is a list of districts, sites, buildings, structures, and objects that are significant in American history, architecture, archaeology, engineering, and culture. Section 110(f) of the National Historic Preservation Act of 1966, as amended, requires that before approval of any federal undertaking that may directly and adversely affect any National Historic Landmark, the head of the responsible federal agency will, to the maximum extent possible, undertake such planning and actions as may be necessary to minimize harm to the landmark, and will afford the Advisory Council a reasonable opportunity to comment on the undertaking.

The National Historic Preservation Act requires federally funded projects to identify and mitigate impacts of project activities on properties included in or eligible for the National Register of Historic Places. No historic building or landmark is present at the OU 5 sites. Therefore, the National Historic Preservation Act is not a potential ARAR.

### A3.2.1.2 ARCHAEOLOGICAL AND HISTORIC PRESERVATION ACT

The Archaeological and Historic Preservation Act, 16 U.S.C. § 469–469c-1, provides for the preservation of historical and archaeological data that might otherwise be lost as a result of dam construction or alterations of the terrain. If activities in connection with any federal construction project or federally approved project may cause irreparable loss to significant scientific, prehistorical, or archaeological data, the act requires the agency undertaking that project to preserve the data or request the Department of the Interior (DOI) to do so. This act differs from the NHPA in that it encompasses a broader range of resources than those listed on the National Register and mandates only the preservation of the data (including analysis and publication).

The Archaeological and Historic Preservation Act requires that for federally approved projects that may cause irreparable loss to significant scientific, prehistoric, historic, or archaeological data, the data must be preserved by the agency undertaking the project or the agency undertaking the project may request DOI to do so. No prehistoric or historic sites were identified in existing data for the OU 5 sites that potentially could be impacted by the remedial action. However, Phase I archaeological surveys will be conducted if any well installation or excavation is to be located in a previously undisturbed area. If archaeological resources are identified, this act may be a potentially relevant and appropriate ARAR.

### A3.2.1.3 HISTORIC SITES, BUILDINGS, AND ANTIQUITIES ACT OF 1935

The purpose of the Historic Sites, Buildings, and Antiquities Act (16 U.S.C. §§ 461–467) and its implementing regulations (40 CFR § 6.301[c]) is to encourage the long-term preservation of nationally significant properties that illustrate or commemorate the history and prehistory of the United States, including historic landmarks (36 CFR § 65)

and natural landmarks (36 CFR § 62). Properties designated as National Historic Landmarks in California are listed in the National Register. Natural landmarks are nationally significant examples of a full range of ecological and geological features that constitute the nation's natural heritage. In conducting an environmental review of a proposed action, the responsible official shall consider the existence and location of natural landmarks using information provided by the National Park Service pursuant to 36 CFR § 62.6(d) to avoid undesirable impacts on such landmarks. These requirements are not substantive and are not potential ARARs. However, if it is determined that areas to be disturbed during the response action are potentially eligible for the National Natural Historic Landmark Program, the State Historic Preservation Officer should be contacted.

#### A3.2.1.4 ARCHAEOLOGICAL RESOURCES PROTECTION ACT OF 1979

Public Law (Pub. L. No.) 96-95 (16 U.S.C. § 470aa–470mm) was enacted in 1979 and amended in 1988 and applies to all lands to which the fee title is held by the United States. The purpose of this statute is to provide for the protection of archaeological resources on federal and Indian lands. The act prohibits unauthorized excavation, removal, damage, alteration, or defacement of archaeological resources located on public lands unless such activity is pursuant to a permit issued under Section 470cc.

For the subject OU 5 sites, there is no data indicating the presence of archaeological resources.

### A3.2.2 Wetlands Protection and Floodplains Management ARARs

Sites 1A-1 and 1111 are within a floodplain. None of the OU 5 sites are considered a potential wetland. The following requirements were evaluated for potential ARAR status for sites within floodplains as appropriate:

- Exec. Order No. 11988, Floodplain Management (40 CFR § 6.302[b]);
- Clean Water Act, Section 404, 33 U.S.C. § 1344; and/or
- RCRA (42 U.S.C. §§ 6901–6991[i]), CCR Title 22, § 66264.18(b).

#### A3.2.2.1 FEDERAL

***Floodplain Management, Exec. Order No. 11988***

Under 40 CFR § 6.302(b), federal agencies are required to evaluate the potential effects of action they may take in a floodplain to avoid, to the extent possible, adverse effects associated with direct and indirect development of a floodplain.

Sites 1A-1 and 1111 are within a floodplain. Therefore, 40 CFR § 6.302(b) is a potentially applicable ARAR for the remedial action for these sites. Also potentially applicable to the groundwater treatment proposed at Site 1111.

***Clean Water Act (33 U.S.C. § 1344)***

Section 404 of the Clean Water Act of 1977 governs the discharge of dredged and fill material into waters of the United States, including adjacent wetlands. Wetlands are

areas that are inundated by water frequently enough to support vegetation typically adapted for life in saturated soil conditions. Wetlands include swamps, marshes, bogs, sloughs, potholes, wet meadows, river overflows, mudflats, natural ponds and similar areas. Both the USEPA and the U.S. Army Corps of Engineers have jurisdiction over wetlands. USEPA's Section 404 guidelines are promulgated in 40 CFR § 230, and the U.S. Army Corps of Engineer's guidelines are promulgated in 33 CFR § 320.

Discharge of dredged or fill material to a wetland is not planned as part of the response action.

***Resource Conservation and Recovery Act (42 U.S.C. §§ 6901–6991[i])***

Under CCR Title 22, § 66264.18(b), any hazardous waste facility located in a 100-year floodplain or within the maximum high tide must be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood or maximum high tide, unless the owner or operator can demonstrate that procedures are in effect that will cause the waste to be removed safely, before flood or tidewater can reach the facility.

Sites 1A-1 and 1111 are located within a floodplain. Therefore, these floodplain requirements may be applicable if hazardous waste is generated and stored during the proposed remedial action alternatives. Also potentially applicable to the groundwater treatment proposed for Site 1111.

#### A3.2.2.2 STATE

The state RCRA requirements for floodplains are evaluated above as potential federal ARARs.

### A3.2.3 Biological Resources ARARs

No endangered or threatened species have been observed at 12 Area, Site 13. The California coastal gnatcatcher has been observed at Site 1A-1. The southwest willow flycatcher, the least Bell's vireo and the arroyo southwestern toad are federally endangered species and the California gnatcatcher is a federally listed threatened species that have been observed or their habitat is present on or near Site 1111. Migratory birds have been observed in the vicinity of Sites 1A-1 and 1111. The following requirements were evaluated for ARAR status as appropriate for the sites:

- Endangered Species Act of 1973 (substantive provisions of 16 U.S.C. §§ 1531–1543),
- Migratory Bird Treaty Act of 1972 (substantive provisions of 16 U.S.C. §§ 703–712),
- Marine Mammal Protection Act (substantive provisions of 16 U.S.C. §§ 1361–1421h),
- Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §§ 1801–1882),
- National Wildlife Refuge System Administration Act of 1996 (16 U.S.C. § 668dd–668ee, substantive provisions of 50 CFR § 27.11–27.97),

- Wilderness Act (16 U.S.C. §§ 1131–1136, 50 CFR § 35.1–35.14), and/or
- California Endangered Species Act (Cal. Fish & Game Code, ch. 1.5, §§ 2050–2116).]

## A3.2.3.1 FEDERAL

### *Endangered Species Act of 1973*

The Endangered Species Act (ESA) of 1973 (16 U.S.C. §§ 1531–1543) provides a means for conserving various species of fish, wildlife, and plants that are threatened with extinction. The ESA defines an endangered species and provides for the designation of critical habitats. Federal agencies may not jeopardize the continued existence of any listed species or cause the destruction or adverse modification of critical habitat. Under Section 7(a) of the ESA, federal agencies must carry out conservation programs for listed species. The Endangered Species Committee may grant an exemption for agency action if reasonable mitigation and enhancement measures such as propagation, transplantation, and habitat acquisition and improvement are implemented. Consultation regulations at 50 CFR § 402 are administrative in nature and are therefore not ARARs. However, they may be TBCs to comply with the substantive provisions of the ESA.

No endangered species have been observed at 12 Area, Site 13. The California coastal gnatcatcher (a federally listed threatened species) has been observed at Site 1A-1. The southwest willow fly-catcher, the least Bell's vireo and the arroyo southwestern toad are federally listed endangered species that have been observed or their habitat is present on Site 1111. The requirements of the ESA at 16 U.S.C. § 1536(a), (h)(1)(B) are potentially applicable for the actions proposed at Sites 1A-1 and 111.

### *Migratory Bird Treaty Act of 1972*

The Migratory Bird Treaty Act (16 U.S.C. §§ 703–712) prohibits at any time, using any means or manner, the pursuit, hunting, capturing, and killing or attempting to take, capture, or kill any migratory bird. This act also prohibits the possession, sale, export, and import of any migratory bird or any part of a migratory bird, as well as nests and eggs. A list of migratory birds for which this requirement applies is found at 50 CFR § 10.13. It is the DON's position that this act is not legally applicable to DON actions; however, Exec. Order No. 13186 (dated 10 January 2001) requires each federal agency taking actions that have or are likely to have a measurable effect on migratory bird populations to develop and implement, within 2 years, a memorandum of understanding (MOU) with the United States Fish and Wildlife Service (USFWS) to promote the conservation of such populations. The DoD and the USFWS are in the process of negotiating this MOU. In the meantime, the Migratory Bird Treaty Act will continue to be evaluated as a potentially relevant and appropriate requirement for DON CERCLA response actions.

Migratory birds have been observed in the vicinity of Sites 1A-1 and 1111. Therefore, the substantive provisions of 16 U.S.C. § 703 are potentially relevant and appropriate for the actions proposed at Sites 1A-1 and 1111 that could result in a take

## A3.2.3.2 STATE

### *California Endangered Species Act*

The California Endangered Species Act is codified in the California Fish and Game Code (Cal. Fish & Game Code) §§ 2050–2116. It is the DON's position that the requisite federal sovereign immunity waiver does not exist to authorize applicability of the California Endangered Species Act. Nevertheless, this act will be evaluated as a potentially relevant and appropriate requirement for the DON's CERCLA response actions. Cal. Fish & Game Code § 2080 prohibits the take of endangered species.

No endangered species have been observed at 12 Area, Site 13. The federally listed threatened species California coastal gnatcatcher observed at Site 1A-1 is not a listed State endangered or threatened species. The southwestern willow flycatcher and the least Bell's vireo are state listed endangered species. However, the same species are federally listed endangered and the state requirements are no more stringent than the federal requirements. Therefore, these are not potential ARARs for OU 5 sites.

### *Other California Department of Fish and Game Requirements*

California Fish and Game Code §5650(a) and (f) prohibits the passage of enumerated substances or materials into waters of the state deleterious to fish, plant life, or birds. This has been determined to be a potential ARAR for excavation at Sites 1A-1 and 1111 where materials may be placed where they could enter surface water.

Other California Department of Fish and Game requirements were also identified as potentially relevant and appropriate requirements. These requirements are not potential ARARs for overlapping federal ARARs. The state requirements are not more stringent for the federally-protected species. However, the state requirements may be broader in scope than the federal ARARs and may address additional species. For these non-federally protected species, the following paragraphs identify potentially relevant and appropriate requirements during proposed remedial actions.

Cal. Fish and Game Code §3005(a) prohibits the taking of birds and mammals, including the taking by poison for birds and mammals. Under Cal. Fish and Game Code §3503, it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided. Under Cal. Fish and Game Code §3503.5, it is unlawful to take, possess, or destroy any birds in the orders Falconiformes or Strigiformes (birds-of-prey) or to take, possess, or destroy the nest or eggs of any such bird except as otherwise provided. The potential species that could be affected at MCB Camp Pendleton include mostly those addressed by federal ARARs. However, the white-tailed kite is not included on the list of migratory birds that are federally protected. Therefore, Cal. Fish and Game Code §3503.5 is potentially relevant and appropriate for remedial actions that may affect the white-tailed kite. Under Cal. Fish and Game Code §3800(a), it is unlawful to take non-game birds except as provided. Under Cal. Fish and Game Code § A fur-bearing mammal may be taken only with a trap, a firearm, bow and arrow, poison under a proper permit, or with the use of dogs. And under Cal. Fish and Game Code §4150, non-game mammals may not be taken or possessed except as provided.

## A3.2.4 Geologic Characteristics ARARs

There are no known geologic characteristics that are regulated by these requirements at the OU 5 sites.

- RCRA (42 U.S.C. §§ 6901–6991[i]), hazardous waste facility siting criteria, CCR Title 22, §§ 66264.18(a) and (c)]

### A3.2.4.1 FEDERAL

***Resource Conservation and Recovery Act (42 U.S.C. §§ 6901–6991[i])***

Hazardous waste facilities must be sited in accordance with the following requirements:

- Seismic considerations (CCR Title 22, § 66264.18(a) – portions of new facilities or facilities undergoing substantial modification where transfer, treatment, storage or disposal of hazardous waste will be conducted shall not be located within 61 meters (200 feet) of a fault which has had displacement in Holocene time.
- Salt dome formations, salt bed formations, underground mines and caves (CCR Title 22, § 66264.18[c]) – the placement of any noncontainerized or bulk liquid hazardous waste in any salt dome formation, salt bed formation, or underground mine or cave is prohibited.

The OU 5 sites are not located within 61 meters of a Holocene fault and no discharge is proposed to a salt dome formation, salt bed formation, or underground mines or caves. Therefore, the requirements at CCR Title 22, § 66264.18(a) and § 66264.18(c) are not potential ARARs for this remedial action.

### A3.2.4.2 STATE

The state location-specific RCRA requirements for geologic characteristics are evaluated above as potential federal ARARs.

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## Table A3-1
## Potential Federal Location-Specific ARARs

| Location | Requirement | Prerequisite | Citation[a] | ARAR Determination | Comments |
|---|---|---|---|---|---|
| **National Historic Preservation Act of 1966, as Amended (16 U.S.C. § 470–470x-6)[b]** | | | | | |
| Historic project owned or controlled by federal agency | Action to preserve historic properties; planning of action to minimize harm to properties listed on or eligible for listing on the National Register of Historic Places. | Property included in or eligible for the National Register of Historic Places. | 16 U.S.C. § 470–470x-6<br>36 C.F.R. pt. 800<br>40 C.F.R. § 6.301(b) | Not an ARAR | Not a historic project |
| **Archaeological and Historic Preservation Act (16 U.S.C. § 469–469c-1)[b]** | | | | | |
| Within area where action may cause irreparable harm, loss, or destruction of significant artifacts | Construction on previously undisturbed land would require an archaeological survey of the area. Data recovery and preservation would be required if significant archaeological or historical data were found on-site. The responsible official or Secretary of the Interior is authorized to undertake data recovery and preservation. | Regulated alteration of terrain caused as a result of a federal construction project or federally licensed activity or program where action may cause irreparable harm, loss, or destruction of significant artifacts. | 16 U.S.C. § 469–469c-1<br>40 C.F.R. § 6.301(c) | Not an ARAR | Previous surveys of the Base have not indicated the OU5 sites as a potential concern. |
| **Archaeological Resources Protection Act of 1979, as Amended (16 U.S.C. § 470aa–470mm)[b]** | | | | | |
| Archaeological resources on federal land | Prohibits unauthorized excavation, removal, damage, alteration, or defacement of archaeological resources located on public lands unless such action is conducted pursuant to a permit. | Archaeological resources on federal land. | Pub. L. No. 96-95<br>16 U.S.C. § 470aa–470mm | Not an ARAR | No potential for archaeological resources at proposed excavation sites. Sites are only proposing removal of deposited wastes. |

(table continues)

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**Table A3-1** (continued)

| Location | Requirement | Prerequisite | Citation[a] | ARAR Determination | Comments |
|---|---|---|---|---|---|
| **Exec. Order No. 11990, Protection of Wetlands[b]** | | | | | |
| Wetland | Action to minimize the destruction, loss, or degradation of wetlands. | Wetland meeting definition of Section 7. | 40 C.F.R. § 6.302(a) | Not an ARAR | Not an ARAR for Sites 1A-1, 1111 and 12 Area, Site 13. |
| **Exec. Order No. 11988, Floodplain Management[b]** | | | | | |
| Within floodplain | Actions taken should avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values. | Action that will occur in a floodplain (i.e., lowlands) and relatively flat areas adjoining inland and coastal waters and other flood-prone areas. | 40 C.F.R. § 6.302(b)<br>40 C.F.R. pt. 6, app. A, excluding § 6(a)(2), 6(a)(4), and 6(a)(6) | Applicable. | Not an ARAR for 12 Area, Site 13. Potentially applicable for Sites 1A-1 and 1111 for soil work. Potentially applicable for Site 1111 for the groundwater treatment alternative. |
| **Clean Water Act of 1977, as Amended, Section 404 (33 U.S.C. § 1344)[b]** | | | | | |
| Wetland | Action to prohibit discharge of dredged or fill material into wetland without permit. | Wetland as defined by Exec. Order No. 11990 Section 7. | 33 U.S.C. § 1344 | Not an ARAR | No dredging or fill proposed. |
| **Resource Conservation and Recovery Act (42 U.S.C. §§ 6901–6991[i])[b]** | | | | | |
| Within 100-year floodplain | Facility must be designed, constructed, operated, and maintained to avoid washout. | RCRA hazardous waste; treatment, storage, or disposal of hazardous waste. | Cal. Code Regs. tit. 22, § 66264.18(b) | Applicable | Not applicable for 12 Area, Site 13. Potentially applicable for Sites 1A-1 and 1111. Potentially applicable for Site 1111 for the groundwater treatment alternative. |
| **Wild and Scenic Rivers Act (16 U.S.C. §§ 1271–1287)[b]** | | | | | |
| Within area affecting national wild, scenic, or recreational river | Avoid taking or assisting in action that will have direct adverse effect on scenic river. | Activities that affect or may affect any of the rivers specified in 16 U.S.C. §1276(a). | 16 U.S.C. §§ 1271–1287 | Not an ARAR | None of the listed rivers are at MCB Camp Pendleton. |

(table continues)

**Table A3-1** (continued)

| Location | Requirement | Prerequisite | Citation[a] | ARAR Determination | Comments |
|---|---|---|---|---|---|
| **Fish and Wildlife Coordination Act (16 U.S.C. §§ 661–666c)[b]** | | | | | |
| Area affecting stream or other water body | Action taken should protect fish or wildlife. | Diversion, channeling, or other activity that modifies a stream or other water body and affects fish or wildlife. | 16 U.S.C. § 662 | Not an ARAR | No diversion, channeling, or other activity to modify a stream or water body is proposed. |
| **Rivers and Harbors Act of 1899 (33 U.S.C. §§ 401–413)[b]** | | | | | |
| Navigable waters | Permits required for structures or work in or affecting navigable waters. | Activities affecting navigable waters. | 33 U.S.C. § 403<br>33 C.F.R. § 322 | Not an ARAR | None of the OU5 sites are located near the coast. |
| **Endangered Species Act of 1973 (16 U.S.C. §§ 1531–1543)[b]** | | | | | |
| Habitat upon which endangered species or threatened species depend | Federal agencies may not jeopardize the continued existence of any listed species or cause the destruction or adverse modification of critical habitat. The Endangered Species Committee may grant an exemption for agency action if reasonable mitigation and enhancement measures such as propagation, transplantation, and habitat acquisition and improvement are implemented. | Determination of effect upon endangered or threatened species or its habitat. Critical habitat upon which endangered species or threatened species depend. | 16 U.S.C. § 1536(a), (h)(1)(B) | Applicable | Not an ARAR for 12 Area, Site 13 where no endangered species have been observed. Potentially applicable for Sites 1A-1 and 1111 where federally listed species are potentially present or have been observed. |

table continues)

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**Table A3-1** (continued)

| Location | Requirement | Prerequisite | Citation[a] | ARAR Determination | Comments |
|---|---|---|---|---|---|
| **Migratory Bird Treaty Act of 1972 (16 U.S.C. §§ 703–712)[b]** | | | | | |
| Migratory bird area | Protects almost all species of native migratory birds in the U.S. from unregulated "take," which can include poisoning at hazardous waste sites. | Presence of migratory birds. | 16 U.S.C. § 703 | Relevant and appropriate | Potentially relevant and appropriate for Sites 1111, and 1A-1 where migratory birds have been observed in the vicinity and action is proposed that may affect birds. |
| **Marine Mammal Protection Act (16 U.S.C. §§ 1361–1421h)[b]** | | | | | |
| Marine mammal area | Protects any marine mammal in the U.S. except as provided by international treaties from unregulated "take." | Presence of marine mammals. | 16 U.S.C. § 1372(a)(2) | Not an ARAR | None of the sites is located near marine water bodies. |
| **Magnuson-Stevens Fishery Conservation and Management Act of 1976, as Amended (16 U.S.C. §§ 1801–1882)[b]** | | | | | |
| Fishery under management | Provides for conservation and management of specified fisheries within specified fishery conservation zones. | Presence of managed fisheries. | 16 U.S.C. §§ 1801–1882 | Not an ARAR | None of the sites is located near managed fisheries. |

(table continues)

**Table A3-1** (continued)

| Location | Requirement | Prerequisite | Citation[a] | ARAR Determination | Comments |
|---|---|---|---|---|---|
| **National Wildlife Refuge System Administration Act of 1996 (16 U.S.C. § 668dd–668ee)[b]** | | | | | |
| Wildlife refuge | No person shall take any animal or plant on any national wildlife refuge, except as authorized under 50 C.F.R. § 27.51. The disposing or dumping of wastes is prohibited. | Area designated as part of National Wildlife Refuge System. | 16 U.S.C § 668dd–668ee<br>Substantive provisions of 50 C.F.R. § 27.11–27.97 | Not an ARAR | None of the sites is within a wildlife refuge. |
| **Wilderness Act (16 U.S.C. §§ 1131–1136)[b]** | | | | | |
| Wilderness area | Area must be administered in such a manner as will leave it unimpaired as wilderness and preserve its wilderness character. | Federally owned area designated as wilderness area. | 16 U.S.C. §§ 1131–1136<br>50 C.F.R. §§ 35.1–35.14 | Not an ARAR | None of the sites is within a wilderness area. |
| **Coastal Zone Management Act (16 U.S.C. §§ 1451–1464)[b]** | | | | | |
| Within coastal zone | Conduct activities in a manner consistent with approved state management programs. | Activities affecting the coastal zone including lands thereunder and adjacent shore land. | 16 U.S.C. § 1456(c)<br>15 C.F.R. § 930 | Not an ARAR | None of the sites is within the coastal zone. |
| **Resource Conservation and Recovery Act (42 U.S.C. §§ 6901–6991[i])[b]** | | | | | |
| Within 61 meters (200 feet) of a fault displaced in Holocene time | New treatment, storage, or disposal of hazardous waste prohibited. | RCRA hazardous waste; treatment, storage, or disposal of hazardous waste. | Cal. Code Regs. tit. 22, § 66264.18(a) | Not an ARAR | None of the sites is within 200 feet of a Holocene fault. |

(table continues)

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Attorney Privileged Communication and Work Product – Do Not Disclose

**Table A3-1** (continued)

| Location | Requirement | Prerequisite | Citation[a] | ARAR Determination | Comments |
|---|---|---|---|---|---|
| Within salt dome formation, underground mine, or cave | Placement of noncontainerized or bulk liquid hazardous waste prohibited. | RCRA hazardous waste; placement. | Cal. Code Regs. tit. 22, § 66264.18(c) | Not an ARAR | No salt domes or underground mines or caves have been identified at any of the OU5 sites. |

Notes:

[a] only the substantive provisions of the requirements cited in this table are potential ARARs

[b] statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the DON accepts the entire statutes or policies as potential ARARs; specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific citations are considered potential ARARs

Acronyms/Abbreviations:

app. – appendix
ARAR – applicable or relevant and appropriate requirement
CCC – California Coastal Commission
Cal. Code Regs. – *California Code of Regulations*
C.F.R. – *Code of Federal Regulations*
DON – Department of the Navy
Exec. Order No. – executive order number
FEMA – Federal Emergency Management Agency
pt. – part
Pub. L. No. – public law number
RCRA – Resource Conservation and Recovery Act
§ – section
U.S. – United States
U.S.C. – *United States Code*

## Table A3-2
## Potential State Location-Specific ARARs

| Location | Requirement | Prerequisite | Citation[a] | ARAR Determination | Comments |
|---|---|---|---|---|---|
| **California Endangered Species Act (Cal. Fish & Game Code §§ 2050–2116)[b]** | | | | | |
| Endangered species habitat | No person shall import, export, take, possess, or sell any endangered or threatened species or part or product thereof. | Threatened or endangered species determination on or before 01 January 1985 or a candidate species with proper notification. | Cal. Fish & Game Code § 2080 | Not an ARAR | No endangered species have been observed at 12 Area, Site 13. The state threatened or endangered species at other OU5 sites are also listed as federally endangered species. The state endangered species requirements are not more stringent than the federal ARARs identified for the endangered species. |
| **Other California Fish and Game Requirements** | | | | | |
| | Prohibits the passage of enumerated substances or materials into waters of the state deleterious to fish, plant life, or birds. | | Fish and Game Code section 5650 (a) and (f) | Relevant and appropriate | Substantive provisions may be relevant and appropriate for excavation at Sites 1A-1 and 1111 where materials might be placed where they could enter surface waters. |
| | Prohibits the taking of birds and mammals, including the taking by poison. | | Fish and Game Code section 3005(a) | Relevant and appropriate | Not an ARAR for federally protected species. Potentially relevant and appropriate for remedial actions for non-federally protected species. |
| | It is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided | | Fish and Game Code section 3503 | Relevant and appropriate | Not an ARAR for federally protected species. Potentially relevant and appropriate for remedial actions for non-federally protected species. |

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| | | | |
|---|---|---|---|
| It is unlawful to take, possess, or destroy any birds in the orders Falconiformes or Strigiformes (birds-of-prey) or to take, possess, or destroy the nest or eggs of any such bird except as otherwise provided | Fish and Game Code section 3503.5 | Relevant and appropriate | Not an ARAR for federally protected species. Potentially relevant and appropriate for remedial actions for the White-tailed Kite. |
| It is unlawful to take non-game birds except as provided. | Fish and Game Code section 3800(a) | Relevant and appropriate | Not an ARAR for federally protected species. Potentially relevant and appropriate for remedial actions for non-federally protected species. |
| A fur-bearing mammal may be taken only with a trap, a firearm, bow and arrow, poison under a proper permit, or with the use of dogs. | Fish and Game Code section 4002 | Relevant and appropriate | Not an ARAR for federally protected species. Potentially relevant and appropriate for remedial actions for non-federally protected species. |
| Non-game mammals may not be taken or possessed except as provided. | Fish and Game Code section 4150 | Relevant and appropriate | Not an ARAR for federally protected species. Potentially relevant and appropriate for remedial actions for non-federally protected species. |

Notes:

[a] only the substantive provisions of the requirements cited in this table are potential ARARs

[b] statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the DON accepts the entire statutes or policies as potential ARARs; specific potential ARARs follow each general heading; only substantive requirements of the specific citations are considered potential ARARs

Acronyms/Abbreviations:

ARAR – applicable or relevant and appropriate requirement
Cal. Code Regs. – *California Code of Regulations*
Cal. Fish & Game Code – *California Fish and Game Code*
Cal. Pub. Res. Code – *California Public Resources Code*
CCC – California Coastal Commission
DON – Department of the Navy
§ – section

# Section A4
# ACTION-SPECIFIC ARARs

This FS report evaluates remedial action alternatives for Sites 1A-1 (soil), 1111 (soil and groundwater), and 12 Area, Site 13 (groundwater) at MCB Camp Pendleton. This analysis evaluates ARARs for the following alternatives:

Alternatives:

Soil (S) 1 – No action,

S2 – Institutional Controls

S3 – Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls (Site 1A-1 ONLY),

S4 – Excavation, Off-base Disposal, and Backfill

Groundwater (G) 1 – No Action,

G2 – Institutional Controls and Groundwater Monitoring,

G3 – Monitored Natural Attenuation

G4 – MNA with Residual Source Removal (12 Area, Site 13 ONLY)

G5 – Enhanced Attenuation Via Carbon Addition in Source Area, MNA Outside Source Area (Site 1111 ONLY).

Detailed descriptions of the remedial alternatives are provided in the main text of this RI/FS report.

Tables A4-1 and A4-2 at the end of this section present and evaluate federal and state potential action-specific ARARs for OU 5, respectively. A discussion of the requirements determined to be pertinent to each alternative being evaluated for OU 5 action is presented in this section. A discussion of how the alternative complies with each identified ARAR is also provided.

## A4.1 ALTERNATIVE S1 AND G1 – NO ACTION

There is no need to identify ARARs for the no action alternative because ARARs apply to "any removal or remedial action conducted entirely on site" and "no action" is not a removal or remedial action (CERCLA Section 121(e), 42 U.S.C. § 9621[e]). CERCLA Section 121 (42 U.S.C. § 9621) cleanup standards for selection of a Superfund remedy, including the requirement to meet ARARs, are not triggered by the no action alternative (USEPA, 1991b). Therefore, a discussion of compliance with action-specific ARARs is not appropriate for this alternative.

## A4.2 ALTERNATIVE S2 AND G2 – INSTITUTIONAL CONTROLS

Institutional controls are a proposed alternative for Site 1A-1, Site 1111, and 12 Area, Site 13.

### A4.2.1 FEDERAL ARARs

There are no federal ARARs for land-use controls; however, USEPA and the Navy have developed guidance pertaining to land-use controls. The California Military Environmental Coordination Committee (CMECC) has developed the Institutional Control Protocol at Open Bases for application at active military installations. This protocol is a consensus document that is intended to aid federal and state remedial project managers when incorporating institutional controls into CERCLA response actions. The committee is made up of Cal/EPA, USEPA, and the DON. The DON has agreed that the institutional control protocol for active bases should be followed for sites that require institutional controls as part of their CERCLA response action. Therefore, the Institutional Control Protocol at Open Bases may be a TBC guidance for sites that require institutional controls.

### A4.2.2 STATE ARARs

State ARARs controlling land use restrictions are found in the substantive provisions of California Civil Code (Cal. Civ. Code) § 1471 and the California HSC. This requirement is not an applicable ARAR for the purpose of remedial actions under this FS because none of the OU 5 sites are being transferred from the DON to a non-federal agency, and it is highly unlikely that they will be transferred in the future given their location and training nature of the Base.

The substantive provisions of Cal. Civ. Code § 1471 are the following general narrative standard: "...To do or refrain from doing some act on his or her own land ...where...: (c) each such act relates to the use of land and each such act is reasonably necessary to protect present or future human health or safety or the environment as a result of the presence on the land of hazardous materials, as defined in section 25260 of the health and safety code." This narrative standard would be implemented through incorporation of restrictive environmental covenants in the deed at the time of a transfer. These covenants would be recorded with the environmental restriction covenant and agreement and would run with the land.

## A4.3 ALTERNATIVE GW3 – GROUNDWATER MONITORING

Groundwater monitoring is a proposed alternative for Site 1111 and 12 Area, Site 13.

### A4.3.1 FEDERAL ARARs

Since none of the sites is or was a regulated hazardous waste management unit, the RCRA groundwater monitoring requirements are not potentially applicable. Further evaluation of the RCRA groundwater monitoring requirements was conducted to evaluate whether the requirements are potentially relevant and appropriate.

Section 66264.90 discusses the applicability of the RCRA monitoring requirements. Since the RCRA regulations were effective in July 1982, this section discusses that for units that received waste after the effective date of the RCRA requirements, the monitoring requirements are applicable. However, for units that received waste prior to the 1982 effective date monitoring is required if there is a threat to human health and the

environment. Therefore, the RCRA groundwater monitoring requirements could only be relevant and appropriate to non-regulated units if there was a threat to human health and the environment. Since the groundwater at 12 Area, Site 13 is already protective of human health and the environment and no waste has been left in place, groundwater monitoring is not required for 12 Area, Site 13. However, if soil is left in place at Site 1111, groundwater monitoring may be required. Substantive provisions of the following requirements are potentially relevant and appropriate for the development and implementation of a groundwater monitoring program:

- monitoring (CCR Title 22, § 66264.91[a][1]–[4], and [c])
- constituents of concern (CCR Title 22, § 66264.93)
- concentration limits (CCR Title 22, § 66264.94[a][1] and [3], [c], [d], and [e]) (See Section A 2 for a detailed discussion of concentration limits)
- monitoring points and points of compliance (CCR Title 22, § 66264.95[a] and [b])
- monitoring parameters (CCR Title 22, § 66264.98[e][1]–[5], [i], [j], [k][1]–[3], [4][A] and [D],[5], [7][C]and[D],[n][1],[2][B] and [C])
- statistical method for detecting a release (CCR Title 22, § 66264.97[b][1][A], [b][1][D][1] and [2], [b][4]–[7], [e][6], [12][A] and [B], [13], and [15])
- evaluation monitoring (CCR Title 22, § 66264.99[b], [e][1]–[6], [f][3], and [g]).
- corrective action monitoring (CCR Title 22, § 66264.100[d] and [g][1])

Soil cuttings and water generated in the course of installing and developing monitoring wells would be subject to RCRA requirements at CCR Title 22, § 66262.10(a) and § 66262.11 to determine whether such wastes should be classified as hazardous. Based on RI sampling results, the soil is expected to meet characteristic RCRA hazardous waste levels. Therefore, the waste accumulation and container storage requirements at CCR Title 22, § 66262.34 and 66264.171-175, 177 and 178 are potentially applicable ARARs for the soil at Sites 1A-1 and 1111.

### *Temporary Units (CCR Title 22, § 66264.553)*

Alternative requirements that are protective of human health or the environment may replace design, operating, or closure standards for temporary container storage areas used for storage of hazardous remediation wastes during remedial activities. These units are not subject to RCRA land disposal restrictions (LDRs). The substantive requirements at CCR Title 22, § 66264.553(b), (d), (e), and (f) are potential ARARs for a temporary unit. For example, these requirements may relax the requirements for secondary containment for container storage (CCR Title 22, § 66264.171– 178), based on the considerations for protecting human health and the environment.

The DON has determined that well development water at Site 1111 and 12 Area, Site 13 would not be classified as RCRA-listed hazardous wastes. However, testing would still

be required to classify these materials with respect to the RCRA hazardous waste characteristics. This determination would be made at the time the waste is generated.

### A4.3.2 STATE ARARs

CCR Title 27, §20090 (d) and CCR Title 23, §2511(d) have exemptions for public agencies conducting remedial actions as long as the applicable requirements of respective chapters are implemented to the extent feasible. Under CCR Title 27, §20950, the finding that the waste in the unit no longer poses a threat to water quality shall release the discharger from the need to comply with the SWRCB-promulgated portions of this title, for that unit. Similarly under CCR Title 23, §2580(a), post-closure monitoring is required only as long as the wastes pose a threat to water quality. Since the groundwater at 12 Area, Site 13 is already protective of human health and the environment, the monitoring requirements under these state regulations are not potential ARARs.

For Site 1111, federal groundwater monitoring ARARs have been identified. The state monitoring requirements have been determined not to be more stringent than federal ARARs and are not potential ARARs for Site 1111.

## A4.4 ALTERNATIVE G3 AND G4 – MONITORED NATURAL ATTENUATION

Monitored natural attenuation has been proposed for each of the groundwater Site 1111 and 12 Area, Site 13. No monitoring ARARs have been identified for 12 Area, Site 13 where the groundwater already meets RAOs and there is no waste left in place. The federal monitoring requirements that have been identified as potential ARARs for groundwater monitoring at Site 1111 in Section A.4.3 above are the same for monitored natural attenuation.

## A4.5 ALTERNATIVE S3 – CAPPING

Capping is proposed for Site 1A only. The RCRA landfill capping requirements were evaluated for potential ARAR status. The RCRA requirements are not potentially applicable to Site 1A-1 soil left in place since the site is not a waste management unit. However, the RCRA requirements were evaluated for the potential to be relevant and appropriate.

In some cases, the prescriptive cap is not the most desirable alternative. An example is a case in which the landfill cap will be used in a semiarid or arid area where clay barriers tend to desiccate, crack, and allow infiltration into the landfill wastes. In these types of cases, if it is not necessary to install the prescriptive cap layers to protect groundwater, engineered alternatives such as monolithic soil caps, pavement caps, or flexible membrane liner barrier caps should be pursued.

Under CCR Title 22, § 66264.310(a)(7), a variance is allowed from any of the prescriptive cap requirements as long as it is demonstrated that the prescriptive cap is not necessary to protect public health, water quality, or other environmental quality. This requirements has been determined to be the controlling ARAR for the cap proposed for

Site 1A-1. The cap would be designed as necessary to protect public health, water quality and other environmental quality.

Under CCR Title 27, § 20080(b) and Title 23, § 2510(b), engineered alternatives to the prescriptive landfill cover are allowed when the discharger can demonstrate that the construction or prescriptive standard is not feasible and there is a specific engineered alternative. The specific engineered alternative must be consistent with the performance goal addressed by the particular construction or prescriptive standard and must afford equivalent protection against water quality impairment. Under CCR Title 27, § 20080(c) and Title 23, § 2510(c), to demonstrate that compliance with prescriptive standards is not feasible, the discharger shall demonstrate that compliance with a prescriptive standard either: (1) is unreasonably and unnecessarily burdensome and will cost substantially more than engineered alternatives; or (2) is impractical and will not promote attainment of applicable performance standards considering all relevant technical and economic factors. These factors include present and projected costs of compliance, potential costs for response action in the event that waste or leachate is released to the environment, and the extent to which groundwater resources could be affected.

Under CCR Title 27, § 21090, the RWQCB can allow any alternative final cover that it finds will continue to isolate the waste and irrigation at least as well as would a final cover built in accordance with applicable prescriptive standards.

## A4.6 ALTERNATIVE S4 – EXCAVATION AND TEMPORARY STORAGE OF WASTE FOR OFF-BASE DISPOSAL

This alternative is for soil at Sites 1A-1 and 1111. Since the soil at both sites is potentially a hazardous waste based on sampling results for metal concentrations, the RCRA requirements were evaluated as potential ARARs.

### *Staging Piles (40 CFR § 264.554)*

Although the state of California has not promulgated its own regulation for staging piles, it has obtained interim authorization by rule under 40 CFR § 271.27(a)(2). In a letter dated 18 March 2002, Cal/EPA Department of Toxic Substances Control notified USEPA that California intended to adopt the 22 January 2002 amended corrective action management unit (CAMU) standards rule. California was authorized under RCRA for the 16 February 1993 CAMU rule as required under 40 CFR § 271.27(a)(1) to gain interim authorization for the 2002 amended rule. Therefore, the amended federal regulations at 40 CFR § 264.554 are state regulations. However, since they are federally enforceable as are the other authorized state RCRA requirements (see Section A1.3.1), they are potential federal ARARs.

Regulations at 40 CFR § 264.554 allow relief from LDRs for temporary storage (less than 2 years) of remediation waste on contiguous property. Placing hazardous remediation wastes in a staging pile does not trigger LDRs or minimum technology requirements (MTRs). In addition, physical operations such as mixing, sizing, blending, etc. that are intended to prepare wastes for subsequent management or treatment are allowed to occur in staging piles regardless of whether they technically meet the RCRA

definition of "treatment." The substantive provisions of § 264.554(d)(1)(i–ii), (d)(2), (h), (i), (j), and (k) are potential ARARs for design, operating, and closure criteria for the staging pile.

The staging pile regulations also require that the unit facilitate a remedy that is reliable, effective, and protective (§ 264.554[d][1][i]); and be designed using appropriate measures (e.g., liners, covers, run-on/runoff controls, groundwater monitoring system) to prevent or minimize releases and cross-media transfers of hazardous wastes and constituents (§ 264.554[d][1][ii]). For units located in a previously contaminated area of the facility, all remediation wastes, contaminated containment system components, structures, and equipment that are contaminated with waste or leachate must be removed or decontaminated within 180 days after the operating term of the staging pile expires (§ 264.554[j]). In addition, contaminated subsoils must be decontaminated. For units located on uncontaminated areas of the facility, within 180 days following expiration of the operating term, the staging pile must be closed in accordance with waste pile closure requirements at CCR Title 22, § 66264.258(a) or § 66265.258(a) and the closure performance standards at CCR Title 22, § 66264.111 or § 66265.111 for permitted and interim status facilities, respectively (§ 264.554[k]).

### *Temporary Units (CCR Title 22, § 66264.553)*

Alternative requirements that are protective of human health or the environment may replace design, operating, or closure standards for temporary container storage areas used for storage of hazardous remediation wastes during remedial activities. These units are not subject to RCRA land disposal restrictions (LDRs). The substantive requirements at CCR Title 22, § 66264.553(b), (d), (e), and (f) are potential ARARs for a temporary unit. For example, these requirements may relax the requirements for secondary containment for container storage (CCR Title 22, § 66264.171–.178), based on the considerations for protecting human health and the environment.

### *Construction Activities Stormwater Pollution Prevention Requirements*

On 16 November 1990, USEPA final regulations implementing Section 402(p) of the Clean Water Act (CWA) setting forth the requirements for the Phase I Stormwater NPDES permit requirements were promulgated (55 Federal Register 47990). USEPA's Phase I Stormwater NPDES regulations require that owner/operators of construction activities obtain permit coverage and be in compliance with discharge standards. The Phase II Stormwater Rule was promulgated on 08 December 1999. On 10 March 2003, the new Phase II regulations came into effect. The Phase II requirements effectively lowered the size limit on construction activities covered by the requirements from those disturbing 5 acres or more (Phase I) to 1 acre or more (Phase II). USEPA is looking to states with delegated NPDES programs such as California to take the lead in issuing permits that implement the new regulations.

Section 121(e) of CERCLA exempts on-site CERCLA response actions from permit requirements. CERCLA on-site response actions must comply with federal and state ARARs, the promulgated substantive requirements of the federal and state laws and regulations that are typically implemented via environmental permit processes. The

DON follows the CERCLA process instead of these permitting processes when making CERCLA decisions.

Substantive provisions of USEPA's Stormwater NPDES regulations for construction activities as well as the CWA provisions that they implement are potential applicable federal ARARs for IR sites that involve construction after the effective date of the regulations.

CWA statutory effluent treatment requirements for stormwater discharges from small construction activity are potential federal ARARs. They are specified in Section 402(p)(3)(A) of the CWA (42 U.S.C. § 1342[p][3][A]) to include all standards set forth in Section 402 of the CWA. As for most other discharge categories, those standards are the long-standing best available technology economically achievable (BAT) requirement for toxic pollutants and best conventional pollutant control technology (BCPCT) requirement for conventional pollutants, as well as state water quality standards.

The substantive part of USEPA's CWA/NPDES stormwater program is the requirement to develop and implement best management practices (BMPs) to manage stormwater discharges. Although BMPs have been designated by USEPA as a form of "effluent limitation," they are prescribed management practices rather than more traditional "end-of-pipe" numeric effluent limitations. A stormwater plan is a required procedural mechanism for developing BMPs and obtaining regulatory approval of BMPs in the CWA context. The substantive provisions of the general requirements for stormwater plans and BMPs set forth in 40 CFR § 122.44(k)(2) and (4) are potential federal ARARs for construction activities where 1 acre or more of soil will be disturbed.

## A4.7 ALTERNATIVE G5 – GROUNDWATER TREATMENT

Enhanced Attenuation Via Carbon Addition in Source Area is proposed as part of the G5 alternative for Site 1111. No ARARs were identified for direct injection of a commercial chemical or chemical product for treating groundwater in situ. RCRA subtitle C does not regulate material that is not a hazardous waste and thus does not prohibit the injection of material into groundwater during in situ treatment if the material is not a hazardous waste (USEPA memorandum dated 27 December 2000, Applicability of RCRA Section 3020 to In-situ Treatment of Ground Water).

Soil cuttings for well installation if necessary and well development water would be handled the same as for Alternative G3 (Section A4.3).

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## Table A4-1
## Potential Federal Action-Specific ARARs

Alternatives: Soil (S) 1 – No Action, S2 – Institutional Controls (Sites 1A-1 and 1111), S3 – Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls (Site 1A-1), S4 – Excavation, Off-Base Disposal, and Backfill (Sites 1A-1 and 1111), Groundwater (G) 1 – No Action, G2 – Institutional Controls/Groundwater Monitoring (Site 1111), G3 – Groundwater Monitoring/MNA (12 Area, Site 13), G4 – Groundwater Monitoring/MNA following Source Removal (Sites 1111 and 12 Area, Site 13), G5 – Enhanced Attenuation Via Carbon Addition in Source Area, Groundwater Monitoring /MNA Outside Source Area (Site 1111).

| Action | Requirement | Prerequisite | Citation | ARAR Determination | | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | A | RA | TBC | |
| **Resource Conservation and Recovery Act (42 U.S.C. §§ 6901–6991[i])*** | | | | | | | |
| On-site waste generation | Person who generates waste shall determine if that waste is a hazardous waste. | Generator of waste. | Cal. Code Regs. tit. 22, § 66262.10(a), 66262.11 | S4, G2, G3, G4, and G5 | | | Applicable for operations where waste soil or groundwater is generated. The determination of whether groundwater and/or wastes generated during remedial activities, such as soil cutting from well installation and treatment residues, are hazardous will be made at the time the wastes are generated. |
| | Requirements for analyzing waste for determining whether waste is hazardous. | Generator of waste. | Cal. Code Regs. tit. 22, § 66264.13(a) and (b) | S4, G2, G3, G4, and G5 | | | Potentially applicable for characterizing generated waste soil or groundwater. |
| Hazardous waste accumulation | On-site hazardous waste accumulation is allowed for up to 90 days as long as the waste is stored in containers in accordance with § 66262.171–178 or in tanks, on drip pads, inside buildings, is labeled and dated, etc. | Accumulate hazardous waste. | Cal. Code Regs. tit. 22, § 66262.34 | S4, G2, G3, G4, and G5 | | | Applicable for any operation where hazardous waste is generated. Generated waste soil or groundwater that has the potential to be hazardous waste will be handled as hazardous during characterization. Waste determined to be hazardous will be disposed of within 90 days. |

(table continues)

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**Table A4-1** (continued)

Alternatives: Soil (S) 1 – No Action, S2 – Institutional Controls (Sites 1A-1 and 1111), S3 – Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls (Site 1A-1), S4 – Excavation, Off-Base Disposal, and Backfill (Sites 1A-1 and 1111), Groundwater (G) 1 – No Action, G2 – Institutional Controls/Groundwater Monitoring (Site 1111), G3 – Groundwater Monitoring/MNA (12 Area, Site 13), G4 – Groundwater Monitoring/MNA following Source Removal (Sites 1111 and 12 Area, Site 13), G5 – Enhanced Attenuation Via Carbon Addition in Source Area, Groundwater Monitoring /MNA Outside Source Area (Site 1111).

| Action | Requirement | Prerequisite | Citation | ARAR Determination | | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | A | RA | TBC | |
| Container storage | Containers of RCRA hazardous waste must be:<br>• maintained in good condition,<br>• compatible with hazardous waste to be stored, and<br>• closed during storage except to add or remove waste. | Storage of RCRA hazardous waste not meeting small-quantity generator criteria before treatment, disposal, or storage elsewhere, in a container. | Cal. Code Regs. tit. 22, § 66264.171, .172, .173 | S4, G2, G3, G4, and G5 | | | Potentially applicable for temporary storage of soil or groundwater waste during characterization or, if hazardous, prior to off-site disposal. Temporary storage requirements may be relaxed by 264.553 below. |
| | Inspect container storage areas weekly for deterioration. | | Cal. Code Regs. tit. 22, § 66264.174 | S4, G2, G3, G4, and G5 | | | Potentially applicable for temporary storage of soil or groundwater waste during characterization or, if hazardous, prior to off-site disposal. Temporary storage requirements may be relaxed by 264.553 below. |
| | Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers of free liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system. | Storage in a container of RCRA hazardous waste not meeting small-quantity generator criteria before treatment, disposal, or storage elsewhere. | Cal. Code Regs. tit. 22, § 66264.175(a) and (b) | S4, G2, G3, G4, and G5 | | | Potentially applicable for temporary storage of soil or groundwater waste during characterization or, if hazardous, prior to off-site disposal. Temporary storage requirements may be relaxed by 264.553 below. |
| | Keep containers of ignitable or reactive waste at least 50 feet from the facility property line. | Ignitable or reactive waste. | Cal. Code Regs. tit. 22, § 66264.176 | | | | Not an ARAR. No ignitable or reactive waste is expected. |

(table continues)

**Table A4-1** (continued)

Alternatives: Soil (S) 1 – No Action, S2 – Institutional Controls (Sites 1A-1 and 1111), S3 – Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls (Site 1A-1), S4 – Excavation, Off-Base Disposal, and Backfill (Sites 1A-1 and 1111), Groundwater (G) 1 – No Action, G2 – Institutional Controls/Groundwater Monitoring (Site 1111), G3 – Groundwater Monitoring/MNA (12 Area, Site 13), G4 – Groundwater Monitoring/MNA following Source Removal (Sites 1111 and 12 Area, Site 13), G5 – Enhanced Attenuation Via Carbon Addition in Source Area, Groundwater Monitoring /MNA Outside Source Area (Site 1111).

| Action | Requirement | Prerequisite | Citation | ARAR Determination | | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | A | RA | TBC | |
| Container storage (continued) | Keep incompatible materials separate. Separate incompatible materials stored near each other by a dike or other barrier. | | Cal. Code Regs. tit. 22, § 66264.177 | S4, G2, G3, G4, and G5 | | | Potentially applicable for temporary storage of soil or groundwater waste during characterization or, if hazardous, prior to off-site disposal. Temporary storage requirements may be relaxed by 264.553 below. |
| | At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers and liners. | | Cal. Code Regs. tit. 22, § 66264.178 | S4, G2, G3, G4, and G5 | | | Potentially applicable for temporary storage of soil or groundwater waste during characterization or, if hazardous, prior to off-site disposal. Temporary storage requirements may be relaxed by 264.553 below. |
| Clean closure | Remove or decontaminate all waste residues, contaminated containment system components (liners, etc.), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and manage them as hazardous waste. If waste is left on site, closure and postclosure care requirements are necessary. | Surface impoundments, container or tank liners, and hazardous waste residues or contaminated soil (including soil from dredging or soil disturbed in the course of drilling or excavation) returned to land. Not applicable to material treated, stored, or disposed only before the effective date of the requirements, or if treated *in situ* or consolidated within the area of contamination. | Cal. Code Regs. tit. 22, § 66264.228(a), (b), (e)–(k), (m), (o)–(q) except as it cross-references procedural requirements such as closure plans and annual reports. | S4 | | | Potentially applicable for the closure of temporary staging piles. |

(table continues)



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**Table A4-1** (continued)

Alternatives: Soil (S) 1 – No Action, S2 – Institutional Controls (Sites 1A-1 and 1111), S3 – Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls (Site 1A-1), S4 – Excavation, Off-Base Disposal, and Backfill (Sites 1A-1 and 1111), Groundwater (G) 1 – No Action, G2 – Institutional Controls/Groundwater Monitoring (Site 1111), G3 – Groundwater Monitoring/MNA (12 Area, Site 13), G4 – Groundwater Monitoring/MNA following Source Removal (Sites 1111 and 12 Area, Site 13), G5 – Enhanced Attenuation Via Carbon Addition in Source Area, Groundwater Monitoring /MNA Outside Source Area (Site 1111).

| Action | Requirement | Prerequisite | Citation | ARAR Determination | | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | A | RA | TBC | |
| Waste pile | Alternative requirements that are protective of human health or the environment may replace design, operating, or closure standards for temporary tanks and container storage areas. | | Cal. Code Regs. tit. 22, § 66264.553(b), (d), (e), and (f) | S4, G3, G4, and G5 | | | Potentially applicable for waste containers stored for characterization or staging prior to off-site disposal. |
| | Allows generators to accumulate solid remediation waste in a U.S. EPA-designated pile for storage only, up to 2 years, during remedial operations without triggering LDRs. | Hazardous remediation waste temporarily stored in piles. | 40 C.F.R. § 264.554(d)(1)(i–ii) and (d)(2), (h), (i), (j), and (k) | S4 | | | Potentially applicable for soil excavated and staged prior to characterization and off-site disposal. |
| Monitoring | Owners/operators of RCRA surface impoundment, waste pile, land treatment unit, or landfill shall conduct a monitoring and response program for each regulated unit. | Surface impoundment, waste pile, land treatment unit, or landfill for which constituents in or derived from waste in the unit may pose a threat to human health or the environment. | Cal. Code Regs. tit. 22, § 66264.91(a)(1), (2), (3), (4), (b), and (c), except as it cross-references permit requirements | | G2, G4, G5 | | Potentially relevant and appropriate for Site 1111 monitoring. |

(table continues)

**Table A4-1** (continued)

Alternatives: Soil (S) 1 – No Action, S2 – Institutional Controls (Sites 1A-1 and 1111), S3 – Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls (Site 1A-1), S4 – Excavation, Off-Base Disposal, and Backfill (Sites 1A-1 and 1111), Groundwater (G) 1 – No Action, G2 – Institutional Controls/Groundwater Monitoring (Site 1111), G3 – Groundwater Monitoring/MNA (12 Area, Site 13), G4 – Groundwater Monitoring/MNA following Source Removal (Sites 1111 and 12 Area, Site 13), G5 – Enhanced Attenuation Via Carbon Addition in Source Area, Groundwater Monitoring /MNA Outside Source Area (Site 1111).

| Action | Requirement | Prerequisite | Citation | ARAR Determination | | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | A | RA | TBC | |
| Point of compliance | The POC is a vertical surface, located at the hydraulically downgradient limit of the waste management area that extends through the uppermost aquifer underlying the regulated unit. | Hazardous waste treatment, storage, or disposal facility. | Cal. Code Regs. tit. 22, § 66264.95(a) and (b) | | G2, G4 and G5 | | Not potentially applicable ARAR because the sites are not hazardous waste management units. Potentially relevant and appropriate for groundwater monitoring for Site 1111. |
| Monitoring | Requirements for monitoring groundwater, surface water, and the vadose zone. | Hazardous waste treatment, storage, or disposal facility. | Cal. Code Regs. tit. 22, § 66264.97[b][1][A], [b][1][D][1] and [2], [b][4]–[7], [e][6], [12][A] and [B], [13], and [15 | | G2, G4 and G5 | | Not potentially ARAR because the sites are not hazardous waste management units. Potentially relevant and appropriate for groundwater monitoring for Site 1111. |
| | Requirements for a detection monitoring program. | Hazardous waste treatment, storage, or disposal facility. | Cal. Code Regs. tit. 22, § 66264.98[e][1]–[5], [i], [j], [k][1]–[3], [4][A] and [D],[5], [7][C]and[D],[n][1],[2][B] and [C]) | | G2, G4 and G5 | | Not potentially ARAR because the sites are not hazardous waste management units. Potentially relevant and appropriate for groundwater monitoring for Site 1111. |

(table continues)

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Attorney Privileged Communication and Work Product – Do Not Disclose

**Table A4-1** (continued)

Alternatives: Soil (S) 1 – No Action, S2 – Institutional Controls (Sites 1A-1 and 1111), S3 – Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls (Site 1A-1), S4 – Excavation, Off-Base Disposal, and Backfill (Sites 1A-1 and 1111), Groundwater (G) 1 – No Action, G2 – Institutional Controls/Groundwater Monitoring (Site 1111), G3 – Groundwater Monitoring/MNA (12 Area, Site 13), G4 – Groundwater Monitoring/MNA following Source Removal (Sites 1111 and 12 Area, Site 13), G5 – Enhanced Attenuation Via Carbon Addition in Source Area, Groundwater Monitoring /MNA Outside Source Area (Site 1111).

| Action | Requirement | Prerequisite | Citation | ARAR Determination | | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | A | RA | TBC | |
| Monitoring (continued) | Requirements for an evaluation monitoring program. | Hazardous waste treatment, storage, or disposal facility. | Cal. Code Regs. tit. 22, § 66264.99[b], [e][1]–[6], [f][3], and [g] | | G2, G4 and G5 | | Not potentially ARAR because the sites are not hazardous waste management units. Potentially relevant and appropriate for groundwater monitoring for Site 1111. |
| Corrective action | The owner or operator shall establish and implement, in conjunction with the corrective action measures, a water quality monitoring program that will demonstrate the effectiveness of the corrective action program and be effective in determining compliance with the water quality protection standard and in determining the success of the corrective action measures under subsection (c) of this section. | Hazardous waste treatment, storage, or disposal facility. | Cal. Code Regs. tit. 22, § 66264.100(d) | | G2, G4 and G5 | | Not potentially ARAR because the sites are not hazardous waste management units. Potentially relevant and appropriate for groundwater monitoring for Site 1111. |
| Completion of response action | The corrective action program is complete when compliance with the water quality standard is demonstrated based on the results of sampling and analysis for all constituents of concern for a period of 1 year. | Hazardous waste treatment, storage, or disposal facility. | Cal. Code Regs. tit. 22, § 66264.100(g)(1) | | G2, G4 and G5 | | Not potentially ARAR because the sites are not hazardous waste management units. Potentially relevant and appropriate for groundwater monitoring for Site 1111. |

(table continues)

**Table A4-1** (continued)

Note:

* statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate that the DON accepts the entire statutes or policies as potential ARARs; specific potential ARARs are addressed in the table below each general heading; only substantive requirements of specific citations are considered potential ARARs

Acronyms/Abbreviations:

A – applicable
ARAR – applicable or relevant and appropriate requirement
BAAQMD – Bay Area Air Quality Management District
BACT – best available control technology
BDAT – best demonstrated available technology
CAA – Clean Air Act
Cal. Code Regs. – *California Code of Regulations*
CAMU – corrective action management unit
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R. – *Code of Federal Regulations*
ch. – chapter
CWA – Clean Water Act
DON – Department of the Navy
EE/CA – Engineering Evaluation/Cost Analysis
°F – degrees Fahrenheit
FS – feasibility study
IR – Installation Restoration (Program)
kg/day – kilograms per day
LAER – lowest achievable emission rate
LDR – land disposal restriction
MCAS – Marine Corps Air Station
MCL – maximum contaminant level
mg/dscm – milligrams per dry standard cubic meter
NAAQS – National Ambient Air Quality Standards (primary and secondary)
NPDES – National Pollutant Discharge Elimination System
OU – operable unit
PCB – polychlorinated biphenyl
$PM_{10}$ – particulate matter, less than 10 micrometers in diameter
POC – point of compliance
ppm – parts per million
$ppm_w$ – parts per million by weight
pt. – part
Pub. L. No. – public law number
RA – relevant and appropriate
RAO – remedial action objective
RCRA – Resource Conservation and Recovery Act
RI – remedial investigation
§ – section
SCAQMD – South Coast Air Quality Management District
SDAPCD – San Diego Air Pollution Control District
SDWA – Safe Drinking Water Act
SIP – State Implementation Plan
subpt. – subpart
TBC – to be considered
TCE – trichloroethene
tit. – title
TSCA – Toxic Substances Control Act
UIC – underground injection control
U.S. – United States
U.S.C. – *United States Code*
USDW – underground source of drinking water
U.S. EPA – United States Environmental Protection Agency
VOC – volatile organic compound

Attorney Privileged Communication and Work Product – Do Not Disclose

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## Table A4-2
## Potential State Action-Specific ARARs

Alternatives: Soil (S) 1 – No Action, S2 – Institutional Controls (Sites 1A-1 and 1111), S3 – Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls (Site 1A-1), S4 – Excavation, Off-Base Disposal, and Backfill (Sites 1A-1 and 1111), Groundwater (G) 1 – No Action, G2 – Institutional Controls with Groundwater Monitoring (Site 1111), G3 – Groundwater Monitoring/MNA (12 Area, Site 13), G4 – Groundwater Monitoring/MNA following Source Removal (Sites 1111 and 12 Area, Site 13), G5 – Enhanced Attenuation Via Carbon Addition in Source Area, Groundwater Monitoring /MNA Outside Source Area (Site 1111).

| Action | Requirement | Prerequisite | Citation | ARAR Determination | | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | A | RA | TBC | |
| **State Water Resources Control Board and Regional Water Quality Control Board*** | | | | | | | |
| Discharges to high-quality waters | Incorporated into all Regional Board Basin Plans. Requires that quality of waters of the state that is better than needed to protect all beneficial uses be maintained unless certain findings are made. Discharges to high quality waters must be treated using best practicable treatment or control necessary to prevent pollution or nuisance and to maintain the highest quality water. Requires cleanup to background water quality or to lowest concentrations technically and economically feasible to achieve. Beneficial uses must, at least, be protected. | | SWRCB Res. 68-16 (Policy With Respect to Maintaining High Quality of Waters in California) (Cal. Water Code § 13140, CWA regulations 40 C.F.R. § 131.12) | | | | Not an ARAR. The DON has determined that migration in groundwater is not a discharge governed by the language in SWRCB Res. 68-16. The state does not agree with the DON position regarding the ARAR status. See Section A2.2.1.2 for a complete discussion. |
| Actions affecting water quality | Provides water quality criteria for classifying the beneficial use of groundwater as municipal/domestic. Criteria outlined as follows: total dissolved solids ≤ 3,000 mg/L or yielding 200 gallons per day or serving as a public water system. | Applies in determining beneficial uses for waters that may be affected by discharges of waste. | SWRCB Res. 88-63 ("Sources of Drinking Water Policy") (as contained in the Basin Plans) | G2, G3, G4, G5 | | | Substantive provisions are potential ARARs for determining potential drinking-water sources. See complete discussion in Section A2.2.1.2. |

(table continues)

**Table A4-2** (continued)

Alternatives: Soil (S) 1 – No Action, S2 – Institutional Controls (Sites 1A-1 and 1111), S3 – Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls (Site 1A-1), S4 – Excavation, Off-Base Disposal, and Backfill (Sites 1A-1 and 1111), Groundwater (G) 1 – No Action, G2 – Institutional Controls with Groundwater Monitoring (Site 1111), G3 – Groundwater Monitoring/MNA (12 Area, Site 13), G4 – Groundwater Monitoring/MNA following Source Removal (Sites 1111 and 12 Area, Site 13), G5 – Enhanced Attenuation Via Carbon Addition in Source Area, Groundwater Monitoring /MNA Outside Source Area (Site 1111).

| Action | Requirement | Prerequisite | Citation | ARAR Determination | | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | A | RA | TBC | |
| Actions affecting water quality (continued) | Establishes policies and procedures for the oversight of investigations and cleanup and abatement activities resulting from discharges of waste that affect or threaten water quality. Requires cleanup of all waste discharged and restoration of affected water to background conditions. Requires actions for cleanup and abatement to conform to Res. 68-16 and applicable provisions of Cal. Code Regs. tit. 23, div. 3, ch. 15 as feasible. | Cleanup and discharge of groundwater to groundwater or surface water and establishment of containment zones. | SWRCB Res. 92-49 (Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Cal. Water Code § 13304) (Cal. Water Code § 13307) (02 October 1996) | | | | Not an ARAR. No more stringent than Cal. Code Regs. tit. 22, § 66264.94. See Section A2.2.1.2 of this appendix. |
| **State Water Resources Control Board*** | | | | | | | |
| Landfill capping | Alternatives to construction or prescriptive standards. | Cal. Code Regs. tit. 27 requirements are only applicable for waste discharged after 18 July 1997 unless otherwise noted. | Cal. Code Regs. tit. 27, §§ 20080 (b) and (c) and 21090 | | | | Not an ARAR. No more stringent than the federal ARARs for capping. |

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Attorney Privileged Communication and Work Product – Do Not Disclose

**Table A4-2** (continued)

Alternatives: Soil (S) 1 – No Action, S2 – Institutional Controls (Sites 1A-1 and 1111), S3 – Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls (Site 1A-1), S4 – Excavation, Off-Base Disposal, and Backfill (Sites 1A-1 and 1111), Groundwater (G) 1 – No Action, G2 – Institutional Controls with Groundwater Monitoring (Site 1111), G3 – Groundwater Monitoring/MNA (12 Area, Site 13), G4 – Groundwater Monitoring/MNA following Source Removal (Sites 1111 and 12 Area, Site 13), G5 – Enhanced Attenuation Via Carbon Addition in Source Area, Groundwater Monitoring /MNA Outside Source Area (Site 1111).

| Action | Requirement | Prerequisite | Citation | ARAR Determination | | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | A | RA | TBC | |
| **California Civil Code*** | | | | | | | |
| Land-use controls | Provides conditions under which land-use restrictions will apply to successive owners of land. | Transfer property from the DON to a nonfederal agency. | Cal. Civ. Code § 1471 | S2, S3 G2 G3 G4 G5 | | | Potential ARAR where the DON is transferring property to a nonfederal agency. Substantive provisions are the following general narrative standard: "to do or refrain from doing some act on his or her own land . . . where (c) Each such act relates to the use of land and each such act is reasonably necessary to protect present or future human health or safety or the environment as a result of the presence of hazardous materials, as defined in Section 25260 of the California Health and Safety Code." This narrative standard would be implemented through incorporation of restrictive covenants in the deed at the time of transfer. |
| **California Health and Safety Code*** | | | | | | | |
| | Allows DTSC to enter into an agreement with the owner of a hazardous waste facility to restrict present and future land uses. | Transfer property from the DON to a nonfederal agency. | Cal. Health & Safety Code § 25202.5 | S2, S3 G2 G3 G4 G5 | | | Potential ARAR where the DON is transferring property to a nonfederal agency. Substantive provisions are the general narrative standards to restrict "present and future uses of all or part of the land on which the … facility … is located . . ." |

**Table A4-2** (continued)

Alternatives: Soil (S) 1 – No Action, S2 – Institutional Controls (Sites 1A-1 and 1111), S3 – Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls (Site 1A-1), S4 – Excavation, Off-Base Disposal, and Backfill (Sites 1A-1 and 1111), Groundwater (G) 1 – No Action, G2 – Institutional Controls with Groundwater Monitoring (Site 1111), G3 – Groundwater Monitoring/MNA (12 Area, Site 13), G4 – Groundwater Monitoring/MNA following Source Removal (Sites 1111 and 12 Area, Site 13), G5 – Enhanced Attenuation Via Carbon Addition in Source Area, Groundwater Monitoring /MNA Outside Source Area (Site 1111).

| Action | Requirement | Prerequisite | Citation | ARAR Determination | | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | A | RA | TBC | |
| Land-use controls (continued) | Provides a streamlined process to be used to enter into an agreement to restrict specific use of property in order to implement the substantive use restrictions of Cal. Health & Safety Code § 25232(b)(1)(A)–(E). | Transfer property from the DON to a nonfederal agency. | Cal. Health & Safety Code § 25222.1 | S2, S3 G2 G3 G4 G5 | | | Potential ARAR where the DON is transferring property to a nonfederal agency. Cal. Health & Safety Code § 25222.1 provides the authority for the state to enter into voluntary agreements to establish land-use covenants with the owner of the property. Substantive provision is the general narrative standard: "restricting specified uses of the property." |
| | Prohibits certain uses of land containing hazardous waste without a specific variance. | Hazardous waste property. | Cal. Health & Safety Code § 25232(b)(1)(A)–(E) | S2, S3 G2 G3 G4 G5 | | | Potential ARAR for sites containing hazardous waste. Land-use restrictions will be used to prohibit the following activities at soil sites containing hazardous waste: residential use of the sites, construction of hospitals for humans, schools for persons under 21 years of age, day care centers for children, or any permanently occupied human habitation on the sites. |
| | Provides a process for obtaining a written variance from a land-use restriction. | Transfer property from the DON to a nonfederal agency. | Cal. Health & Safety Code § 25233(c) | S2, S3 G2 G3 G4 G5 | | | Potential ARAR for institutional controls where the DON is transferring property to a nonfederal agency. Cal. Health & Safety Code § 25233(c) sets forth substantive criteria for granting variances from the uses prohibited in subpara. 25232(b)(1) (A)–(E) based on specified environmental and health criteria. |

(table continues)

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**Table A4-2** (continued)

Note:

* statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the DON accepts the entire statutes or policies as potential ARARs; specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific actions are considered potential ARARs.

Acronyms/Abbreviations:

A – applicable
APCD – Air Pollution Control District
AQMD – Air Quality Management District
ARAR – applicable or relevant and appropriate requirement
BAT – best available technology
BPT – best practicable treatment
CAI – closed, abandoned, or inactive
Cal. Code Regs. – *California Code of Regulations*
Cal/EPA – California Environmental Protection Agency
Cal. Fish & Game Code – *California Fish and Game Code*
Cal. Health & Safety Code – *California Health and Safety Code*
Cal. Pub. Res. Code – *California Public Resources Code*
Cal. Water Code – *California Water Code*
CAMU – corrective action management unit
CEQA – California Environmental Quality Act
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R. – *Code of Federal Regulations*
ch. – chapter
CWA – Clean Water Act
div. – division
DON – Department of the Navy
DTSC – (Cal/EPA) Department of Toxic Substances Control
EE/CA – engineering evaluation/cost analysis
FS – feasibility study
LDR – land disposal restriction
mg/L – milligrams per liter
NAWQC – National Ambient Water Quality Control
$PM_{10}$ – particulate matter, less than 10 micrometers in diameter
ppm – parts per million
Prop. – proposition
RA – relevant and appropriate
RAO – removal action objective
RCRA – Resource Conservation and Recovery Act
Res. – resolution
RI – remedial investigation
RWQCB – Regional Water Quality Control Board San Diego Region
§ – section
SCAQMD – South Coast Air Quality Management District
SIP – State Implementation Plan
SWAT – Solid Waste Assessment Test
SWRCB – (California) State Water Resources Control Board
T-BACT – best available control technology for toxics
TBC – to be considered
tit. – title
TPH – total petroleum hydrocarbons
U.S.C. – *United States Code*
UST – underground storage tank
VOC – volatile organic compound
WQO – water quality objective

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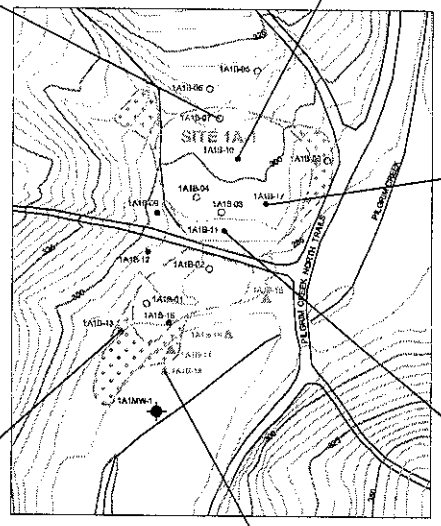
# APPENDIX B
# SELECTED FIGURES FROM THE OU 5 RI (PARSONS, 2004A)

# APPENDIX B1
# SITE 1A-1

| 1A1B-07 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.0 |
| Method | 8280A |
| 2,3,7,8-TCDD Toxicity Equivalents | **2,735.7** |

| 1A1B-10 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.0 |
| Method | 8290 |
| 2,3,7,8-TCDD Toxicity Equivalents | **106.3** |




| 1A1B-17 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.0 |
| Method | 8290 |
| 2,3,7,8-TCDD Toxicity Equivalents | **320.8** |

| 1A1B-11 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.0 |
| Method | 8290 |
| 2,3,7,8-TCDD Toxicity Equivalents | **318.0** |

| 1A1B-13 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.0 |
| Method | 8290 |
| 2,3,7,8-TCDD Toxicity Equivalents | **158.6** |

| 1A1B-19 | |
|---|---|
| Depth (ft bgs) | 0.0 - 0.5 |
| Method | 8290 |
| 2,3,7,8-TCDD Toxicity Equivalents | 1.4 |

**Legend**

- Boundary of Waste Fill Soil (Based on Surface Mapping and Boring Logs)
- Surface Debris (<1-ft thick) (Based on Surface Mapping and Boring Logs)
- Soil Boring Location (2001)
- Soil Boring Location (2003)
- Soil Boring Located in Streambed Sediments (2003)
- Groundwater Monitoring Well Location

N

**Notes**

For complete list of dioxins/furans detected, see Table 2-6

81.1 Results shown in pg/g

**318** Bold text indicates compond detected above industrial soil PRG

0 200 400

Scale in Feet

**Figure 2-7**

**Site 1A-1**
**2,3,7,8-TCDD Toxicity Equivalents Results in Soil**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

fc\ocd\eemiss\ca\compperndleton\OUSRI\RReport\Fig2-07_S1A1solidioxins.dwg

| 1A1B-10 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.0 - 5.0 | 4.0 - 5.0 (D) | 9.0 - 10.0 |
| 4,4'-DDD | 87 | 0.2 J1 | 15 J1 | 0.2 J1 |
| 4,4'-DDE | 170 | < 26 | 30 | < 26 |
| 4,4'-DDT | 33 J1 | < 37 | 20 J1 | < 37 |
| Alpha-Chlordane | < 1 | < 1 | 15 | < 1 |
| Dieldrin | < 31 | < 31 | < 31 | 2 J1 |
| Gamma-Chlordane | < 1 | < 1 | 7.9 | 0.6 J1 |
| Hexachlorobenzene | 8.2 | < 1.8 J | 13 | 0.1 J1 |
| Pentachlorophenol | 0.9 J | < 10 | 4 J1 | < 10 |

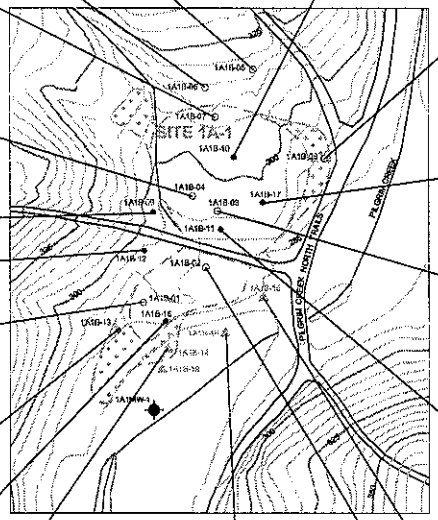
| 1A1B-06 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.5 |
| No Pesticides or Chlorinated Herbicides Detected | |

| 1A1B-05 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.0 |
| No Pesticides or Chlorinated Herbicides Detected | |

| 1A1B-07 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 2.5 - 4.0 | 5.5 - 6.0 |
| 4,4'-DDD | 5 | < 3.1 | < 3.1 |
| 4,4'-DDE | 11 | 0.6 J1 | < 3.1 |
| 4,4'-DDT | 6 | 0.8 J1 | < 3.1 |
| Pentachlorophenol | 3 J1 | 3 J1 | < 10 |

| 1A1B-08 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.5 | 0.0-1.5 (D) | 4.5 - 6.0 |
| 4,4'-DDD | 29 J1 | < 3.2 | < 3.2 |
| 4,4'-DDE | 10 J1 | 17 | < 3.2 |
| 4,4'-DDT | 16 J1 | 13 | < 3.2 |
| Gamma-Chlordane | 2 J1 | < 1.1 | < 1.1 |
| 2,4-DB | < 10 | 17 | < 11 |

| 1A1B-04 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.5 | 4.5 - 6.0 | 4.5 - 6.0 (D) | 8.5 - 10.0 |
| 4,4'-DDD | 16 | 82 | 19 | 71 |
| 4,4'-DDE | 19 | 239 | 14 | 115 |
| 4,4'-DDT | 5 | 37 | 3 J1 | 26 |
| Pentachlorophenol | < 10 | 2 J1 | < 11 | < 10 |




| 1A1B-09 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0 - 0.5 | 4.0 - 5.0 | 9.0 - 10.0 |
| No Pesticides or Chlorinated Herbicides Detected | | | |

| 1A1B-17 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.0 - 5.0 | 4.0 - 5.0 (D) | 9.0 - 10.0 |
| 4,4'-DDD | 87 | 27 J | 4 J | 410 |
| 4,4'-DDE | 180 | 140 J | 21 J | 480 |
| 4,4'-DDT | 32 J1 | 25 J | 4 J | 390 |
| Hexachlorobenzene | 5.8 | 11 J | 4.8 J | 12 |
| Pentachlorophenol | < 11 | 2 J1 | 4 J1 | < 10 |

| 1A1B-12 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.0 |
| No Pesticides or Chlorinated Herbicides Detected | |

| 1A1B-03 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.5 | 4.0 - 6.0 | 8.5 - 10.0 |
| 4,4'-DDD | 5.4 | 171 | 1 J1 |
| 4,4'-DDE | 24 | 300 | 2 J1 |
| 4,4'-DDT | 13 | 82 | 1 J1 |
| Pentachlorophenol | 3 J1 | < 10 | < 11 |

| 1A1B-01 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 3.0 - 4.0 | 4.0 - 4.5 |
| 4,4'-DDD | 981 N | **58,000 N** | 570 N |
| 4,4'-DDE | 2,670 | 20,000 J | 1,800 |
| 4,4'-DDT | 673 | 243,000 | 1,300 |
| Alpha-Chlordane | 9.2 | < 2,700 | < 53 |
| Pentachlorophenol | < 22 | 11 J1 | < 21 |

| 1A1B-11 | | | | | |
|---|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.0 - 5.0 | 4.0 - 5.0 (D) | 9.0 - 10.0 | 14.0 - 15.0 |
| 4,4'-DDD | 28 J1 | 180 | 23 J1 | < 43 | < 43 |
| 4,4'-DDE | 16 J | 140 | < 25 J | < 26 | < 26 |
| 4,4'-DDT | 7 J | 97 | 23 J | < 37 | < 37 |
| Hexachlorobenzene | 5.8 | 44 J | 7.1 | < 1.7 | < 1.8 |
| Pentachlorophenol | 1 J1 | 6 J1 | < 10 | < 10 | < 10 |

| 1A1B-13 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.0 - 5.0 | 9.0 - 10.0 | 13.0 - 14.0 |
| 4,4'-DDE | < 28 | < 25 | < 26 | 3 J1 |
| Hexachlorobenzene | 0.8 J1 | < 1.7 | < 1.7 | < 1.8 |
| No Chlorinated Herbicides Detected | | | | |

| 1A1B-16 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.5 - 5.0 | 4.0 - 5.0 (D) | 9.0 - 10.0 |
| 4,4'-DDE | 3 J1 | < 26 | < 26 | < 27 |
| 4,4'-DDT | 0.4 J1 | < 37 | < 37 | < 39 |
| Pentachlorophenol | 27 | < 10 | < 10 | < 11 |

| 1A1B-18 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.0 |
| 4,4'-DDD | 19 J1 |
| 4,4'-DDE | 30 J1 |
| 4,4'-DDT | 27 J1 |
| Alpha Endosulfan | 1 J1 |
| Dieldrin | 1 J1 |
| Endrin Aldehyde | 0.3 J1 |
| No Chlorinated Herbicides Detected | |

| 1A1B-14 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.0 - 5.0 | 9.0 - 10.0 | 14.5 - 15.5 |
| 4,4'-DDD | 6 J1 | < 44 | 0.3 J1 | < 51 |
| 4,4'-DDE | 10 J1 | < 26 | 5 J1 | < 30 |
| 4,4'-DDT | 13 J1 | < 38 | < 37 | < 43 |
| Hexachlorobenzene | 0.1 J1 | < 1.8 | < 1.8 | < 2 |
| Pentachlorophenol | < 10 | < 11 | < 10 | 1 J1 |

| 1A1B-15 | | | | | |
|---|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.0 - 5.0 | 4.0 - 5.0 (D) | 9.0 - 10.0 | 14.0 - 15.0 |
| 4,4'-DDD | 0.5 J1 | 10 J | 2 J | < 45 | < 48 |
| 4,4'-DDE | 4 J1 | 31 J | 8 J | < 27 | < 29 |
| 4,4'-DDT | 1 J1 | 19 J | 0.8 J | < 38 | < 41 |
| Alpha-Chlordane | 0.2 J1 | < 1.1 | < 1.1 | < 1.1 | < 1.2 |
| Gamma-Chlordane | 0.5 J1 | < 1.1 | < 1.1 | < 1.1 | < 1.2 |
| Hexachlorobenzene | 0.2 J1 | 0.5 J1 | < 1.8 | < 1.8 | < 2 |
| No Chlorinated Herbicides Detected | | | | | |

| 1A1B-02 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.5 | 4.5 - 6.0 | 4.5 - 6.0 (D) | 8.5 - 10.0 |
| 4,4'-DDD | 9 | 10 | 10 | < 3.1 |
| 4,4'-DDE | 77 | 32 | 60 | 0.4 J1 |
| 4,4'-DDT | 7.7 | 14 | 18 | < 3.1 |
| Pentachlorophenol | 5 J1 | < 10 | 15 | 3 J1 |

## Legend

- Boundary of Waste Fill Soil (Based on Surface Mapping and Boring Logs)
- Surface Debris (<1-ft thick) (Based on Surface Mapping and Boring Logs)
- Soil Boring Location (2001)
- Soil Boring Location (2003)
- Soil Boring Located in Streambed Sediments (2003)
- Groundwater Monitoring Well Location

N

**Notes**

| | |
|---|---|
| 81.1 | Results shown in µg/kg |
| <10 | Not detected at indicated value |
| J1 | Estimated Value |
| **58,000** | Bold text indicates compound detected above industrial soil PRG |

0 200 400

Scale in Feet

**Figure 2-8**

**Site 1A-1**
**Pesticides and Chlorinated Herbicides Detected in Soil**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

k:\cad\semiee\ce\campendleton\OU5RI\RIReport\Fig2-06_S1A1soilpestherb.dwg

| 1A1B-06 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.5 |
| No Metals Detected Above Background | |

| 1A1B-05 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.0 |
| No Metals Detected Above Background | |

| 1A1B-07 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 2.5 - 4.0 | 5.5 - 6.0 |
| Antimony | 46.5 | 39.5 | -- |
| Arsenic | 15.8 | 14.9 | -- |
| Barium | 803 | 554 | -- |
| Cadmium | 13 | 9.4 | -- |
| Chromium (Total) | 63.2 | 92.2 | -- |
| Cobalt | 27.1 | 15.2 | -- |
| Copper | 2,630 | 1,990 | -- |
| Iron | 51,800 | 42,200 | -- |
| Lead | 2,540 | 2,050 | -- |
| Manganese | 4,050 | 2,650 | -- |
| Mercury | 0.28 | 0.25 | -- |
| Nickel | 791 | 650 | -- |
| Zinc | 5,520 | 7,100 | -- |

| 1A1B-04 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.5 | 4.5 - 6.0 | 4.5 - 6.0 | 8.5 - 10.0 |
| Arsenic | -- | -- | 7.7 | -- |
| Barium | 394 | -- | -- | -- |
| Lead | 29.9 | -- | -- | 65.5 |
| Mercury | 0.22 | -- | -- | -- |
| Zinc | 114 | -- | -- | -- |

| 1A1B-09 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0 - 0.5 | 4.0 - 5.0 | 9.0 - 10.0 |
| Vanadium | -- | -- | 90.2 |

| 1A1B-12 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.0 |
| No Metals Detected Above Background | |

| 1A1B-01 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 3.0 - 4.0 | 4.0 - 4.5 |
| Antimony | -- | 42.8 | 48 |
| Arsenic | -- | 27.7 | 16.8 |
| Barium | -- | 277 | 348 |
| Cadmium | -- | 12 | 12 |
| Chromium (Total) | -- | 51.1 | 196 |
| Cobalt | -- | 20.3 | 20.1 |
| Copper | 60.2 | 1,040 | 2,130 |
| Iron | -- | 175,000 | 117,000 |
| Lead | 79.7 | 9,870 | 3,690 |
| Manganese | -- | 2,870 | 2,700 |
| Mercury | -- | 0.34 | 0.3 |
| Nickel | -- | 77.9 | 56.2 |
| Zinc | 358 | 5,020 | 5,970 |

| 1A1B-13 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.0 - 5.0 | 9.0 - 10.0 | 13.0 - 14.0 |
| Copper | 93.5 | -- | -- | -- |
| Lead | 889 | -- | -- | -- |
| Zinc | 367 | -- | -- | -- |

| 1A1B-18 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.0 |
| Copper | 51.1 |
| Lead | 76.6 |
| Zinc | 345 |

| 1A1B-14 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.0 - 5.0 | 9.0 - 10.0 | 14.5 - 15.5 |
| Copper | 39.1 | -- | -- | -- |
| Lead | 38 | -- | -- | -- |
| Mercury | 0.13 | 0.083 | -- | -- |
| Zinc | 199 J | -- | -- | -- |

| 1A1B-10 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.0 - 5.0 | 4.0 - 5.0 (D) | 9.0 - 10.0 |
| Antimony | 27.5 J | -- | 37.1 J | -- |
| Arsenic | 7.9 | -- | 12.1 | -- |
| Barium | 322 | -- | 690 | -- |
| Cadmium | 5.2 | -- | 16.5 | -- |
| Chromium (Total) | 41.7 | -- | 112 | -- |
| Cobalt | 13.7 | -- | 23.6 | -- |
| Copper | 920 | -- | 2,180 | -- |
| Iron | 61,100 | -- | 80,900 | -- |
| Lead | 1,050 | -- | 2,340 | -- |
| Manganese | 1,700 | -- | 2,580 | -- |
| Mercury | 0.11 | -- | 0.35 | 0.088 |
| Nickel | 27.9 | -- | 74.8 | -- |
| Zinc | 2,980 | -- | 4,490 | -- |

| 1A1B-08 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.5 | 0.0 - 1.5 | 4.5 - 6.0 |
| Copper | 35.2 | 39.8 | -- |
| Lead | 48.7 | 64.2 | -- |
| Mercury | -- | 0.088 | -- |
| Zinc | 172 | 222 | -- |

| 1A1B-17 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.0 - 5.0 | 4.0 - 5.0 (D) | 9.0 - 10.0 |
| Antimony | -- | -- | 95.2 | 106 J |
| Arsenic | -- | -- | 23.7 | 20.3 J |
| Barium | -- | -- | 437 | 863 J |
| Cadmium | -- | 1.8 J | 9.4 | 13.5 J |
| Chromium (Total) | -- | -- | 60.3 | 87.9 J |
| Cobalt | -- | -- | 30.2 | 17.9 J |
| Copper | 221 | 222 J | 974 | 2,600 J |
| Iron | -- | -- | 177,000 | 67,300 J |
| Lead | 129 | 199 J | 4,690 | 3,380 J |
| Manganese | -- | -- | 1,420 | 4,850 J |
| Mercury | 0.12 | -- | 0.17 | 0.56 J |
| Nickel | -- | -- | 81.1 | 102 J |
| Zinc | 289 J | 613 J | 2,930 J | 8,300 J |

| 1A1B-03 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.5 | 4.0 - 6.0 | 8.5 - 10.0 |
| Antimony | 57.5 | -- | -- |
| Arsenic | 15.9 | 6.7 | 6.8 |
| Barium | 617 | -- | -- |
| Cadmium | 16.9 | -- | -- |
| Chromium (Total) | 114 | -- | -- |
| Cobalt | 19.2 | -- | -- |
| Copper | 2,180 | -- | -- |
| Iron | 84,700 | -- | -- |
| Lead | 7,130 | -- | 25.2 |
| Manganese | 6,230 | -- | -- |
| Mercury | 0.62 | -- | 0.38 |
| Nickel | 61.7 | -- | -- |
| Zinc | 8,650 | -- | -- |

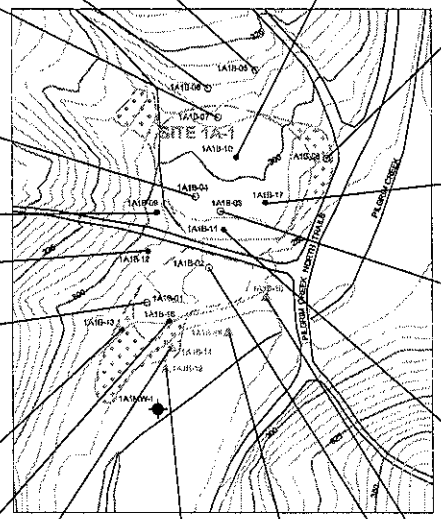
| 1A1B-11 | | | | | |
|---|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.0 - 5.0 | 4.0 - 5.0 (D) | 9.0 - 10.0 | 14.0 - 15.0 |
| Antimony | -- | 34.7 J | -- | -- | -- |
| Cadmium | -- | 3.9 | -- | -- | -- |
| Copper | -- | 779 J | -- | -- | -- |
| Lead | -- | 423 J | -- | -- | -- |
| Manganese | -- | 1,300 | -- | -- | -- |
| Mercury | -- | 0.16 | -- | -- | 0.14 |
| Zinc | -- | 2,290 J | -- | -- | -- |

| 1A1B-16 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.5 - 5.0 | 9.0 - 10.0 | 4.0 - 5.0 |
| No Metals Detected Above Background | | | | |

| 1A1B-19 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.0 |
| No Metals Detected Above Background | |

| 1A1B-02 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.5 | 4.5 - 6.0 | 4.5 - 6.0 | 8.5 - 10.0 |
| Arsenic | -- | 11.5 | -- | -- |
| Barium | -- | 276 | -- | 277 |
| Copper | 68.1 | -- | -- | -- |
| Lead | 63.5 | -- | -- | -- |
| Zinc | 266 | -- | -- | -- |

| 1A1B-15 | | | | | |
|---|---|---|---|---|---|
| Depth (ft bgs) | 0.0 - 1.0 | 4.0 - 5.0 | 4.0 - 5.0 (D) | 9.0 - 10.0 | 14.0 - 15.0 |
| Mercury | -- | 0.14 J | -- | -- | -- |




## Legend

- Boundary of Waste Fill Soil (Based on Surface Mapping and Boring Logs)
- Surface Debris (<1-ft thick) (Based on Surface Mapping and Boring Logs)
- Soil Boring Location (2001)
- Soil Boring Location (2003)
- Soil Boring Located in Streambed Sediments (2003)
- Groundwater Monitoring Well Location

N

**Notes**
For complete list of metals detected, see Table 2-10

81.1 Results shown in mg/kg

-- Indicates compound not detected above background

J Estimated Value

175,000 Bold text indicates compound detected above industrial soil PRG

0 200 400
Scale in Feet

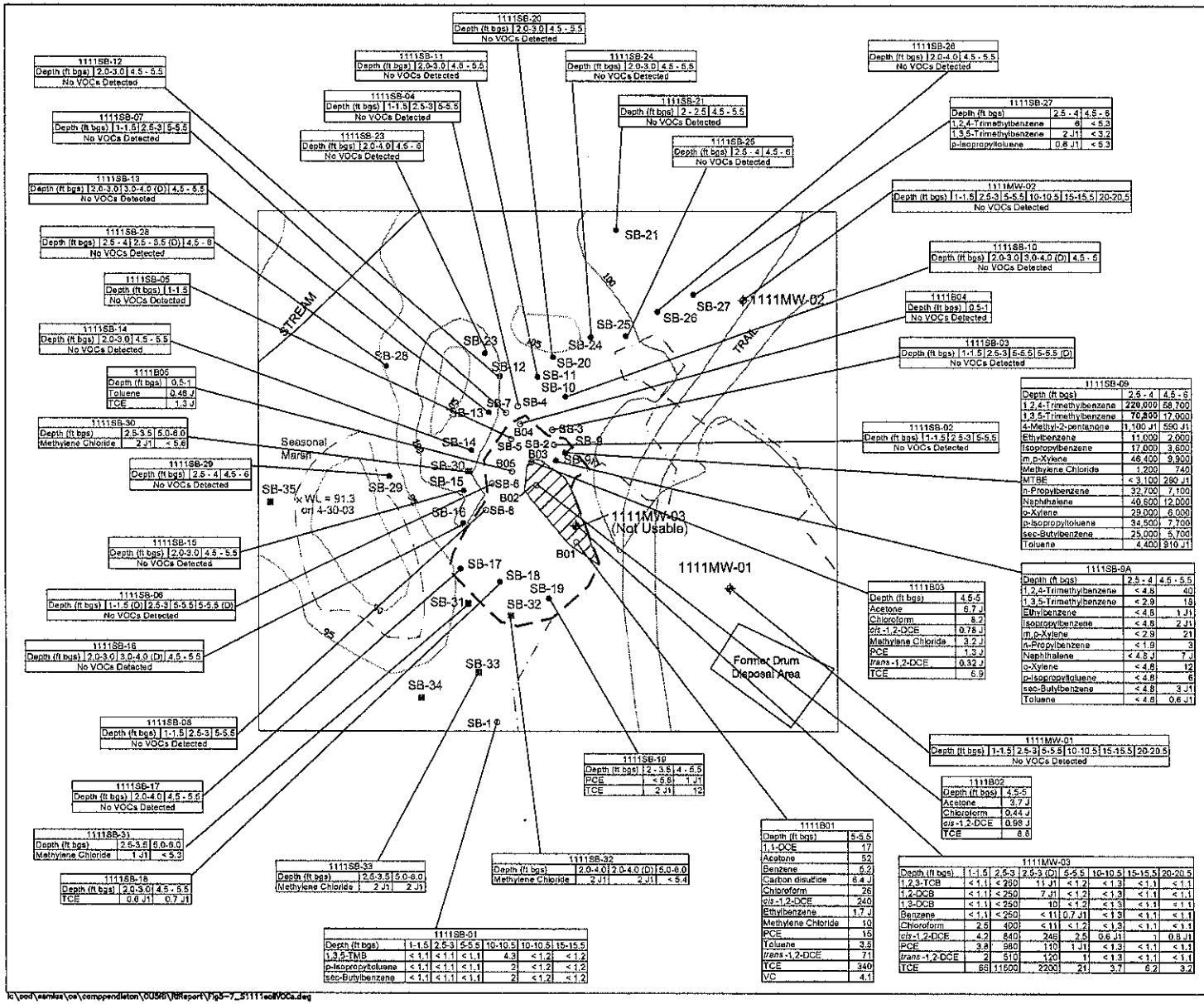
**Figure 2-9**

**Site 1A-1**
**Selected Metals Detected Above Background in Soil**

MCB Camp Pendleton, California
PARSONS
Pasadena, CA

c:\cad\semlee\ce\ccmpendleton\005R\RIReport\Fig2-09_S1A1soilmetals.dwg

# APPENDIX B2
# SITE 1111




| 1111SB-12 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-3.0 | 4.5 - 5.5 | |
| No VOCs Detected | | | |

| 1111SB-07 | | | |
|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 |
| No VOCs Detected | | | |

| 1111SB-13 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-3.0 | 3.0-4.0 (D) | 4.5 - 5.5 |
| No VOCs Detected | | | |

| 1111SB-28 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.5 - 4 | 2.5 - 3.5 (D) | 4.5 - 6 |
| No VOCs Detected | | | |

| 1111SB-05 | |
|---|---|
| Depth (ft bgs) | 1-1.5 |
| No VOCs Detected | |

| 1111SB-14 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-3.0 | 4.5 - 5.5 | |
| No VOCs Detected | | | |

| 1111B05 | |
|---|---|
| Depth (ft bgs) | 0.5-1 |
| Toluene | 0.48 J |
| TCE | 1.3 J |

| 1111SB-30 | | |
|---|---|---|
| Depth (ft bgs) | 2.5-3.5 | 5.0-6.0 |
| Methylene Chloride | 2 J1 | < 5.6 |

| 1111SB-29 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.5 - 4 | 4.5 - 6 | |
| No VOCs Detected | | | |

| 1111SB-15 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-3.0 | 4.5 - 5.5 | |
| No VOCs Detected | | | |

| 1111SB-06 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 (D) | 2.5-3 | 5-5.5 | 5-5.5 (D) |
| No VOCs Detected | | | | |

| 1111SB-16 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-3.0 | 3.0-4.0 (D) | 4.5 - 5.5 |
| No VOCs Detected | | | |

| 1111SB-08 | | | |
|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 |
| No VOCs Detected | | | |

| 1111SB-17 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-4.0 | 4.5 - 5.5 | |
| No VOCs Detected | | | |

| 1111SB-31 | | |
|---|---|---|
| Depth (ft bgs) | 2.5-3.5 | 5.0-6.0 |
| Methylene Chloride | 1 J1 | < 5.3 |

| 1111SB-18 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-3.0 | 4.5 - 5.5 | |
| TCE | 0.6 J1 | 0.7 J1 | |

| 1111SB-20 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-3.0 | 4.5 - 5.5 | |
| No VOCs Detected | | | |

| 1111SB-11 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-3.0 | 4.5 - 5.5 | |
| No VOCs Detected | | | |

| 1111SB-04 | | | |
|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 |
| No VOCs Detected | | | |

| 1111SB-23 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-4.0 | 4.5 - 6 | |
| No VOCs Detected | | | |

| 1111SB-24 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-3.0 | 4.5 - 5.5 | |
| No VOCs Detected | | | |

| 1111SB-21 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2 - 2.5 | 4.5 - 5.5 | |
| No VOCs Detected | | | |

| 1111SB-25 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.5 - 4 | 4.5 - 6 | |
| No VOCs Detected | | | |

| 1111SB-26 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-4.0 | 4.5 - 5.5 | |
| No VOCs Detected | | | |

| 1111SB-27 | | |
|---|---|---|
| Depth (ft bgs) | 2.5 - 4 | 4.5 - 6 |
| 1,2,4-Trimethylbenzene | 6 | < 5.3 |
| 1,3,5-Trimethylbenzene | 2 J1 | < 3.2 |
| p-Isopropyltoluene | 0.6 J1 | < 5.3 |

| 1111MW-02 | | | | | | |
|---|---|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 10-10.5 | 15-15.5 | 20-20.5 |
| No VOCs Detected | | | | | | |

| 1111SB-10 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-3.0 | 3.0-4.0 (D) | 4.5 - 5 |
| No VOCs Detected | | | |

| 1111B04 | |
|---|---|
| Depth (ft bgs) | 0.5-1 |
| No VOCs Detected | |

| 1111SB-03 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 5-5.5 (D) |
| No VOCs Detected | | | | |

| 1111SB-09 | | |
|---|---|---|
| Depth (ft bgs) | 2.5 - 4 | 4.5 - 6 |
| 1,2,4-Trimethylbenzene | **220,000** | **58,700** |
| 1,3,5-Trimethylbenzene | **70,800** | **17,000** |
| 4-Methyl-2-pentanone | 1,100 J1 | 590 J1 |
| Ethylbenzene | 11,000 | 2,000 |
| Isopropylbenzene | 17,000 | 3,600 |
| m,p-Xylene | 46,400 | 9,900 |
| Methylene Chloride | 1,200 | 740 |
| MTBE | < 3,100 | 280 J1 |
| n-Propylbenzene | 32,700 | 7,100 |
| Naphthalene | 40,600 | 12,000 |
| o-Xylene | 29,000 | 6,000 |
| p-Isopropyltoluene | 34,500 | 7,700 |
| sec-Butylbenzene | 25,000 | 5,700 |
| Toluene | 4,400 | 910 J1 |

| 1111SB-02 | | | |
|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 |
| No VOCs Detected | | | |

| 1111SB-9A | | |
|---|---|---|
| Depth (ft bgs) | 2.5 - 4 | 4.5 - 5.5 |
| 1,2,4-Trimethylbenzene | < 4.8 | 40 |
| 1,3,5-Trimethylbenzene | < 2.9 | 18 |
| Ethylbenzene | < 4.8 | 1 J1 |
| Isopropylbenzene | < 4.8 | 2 J1 |
| m,p-Xylene | < 2.9 | 21 |
| n-Propylbenzene | < 1.9 | 3 |
| Naphthalene | < 4.8 J | 7 J |
| o-Xylene | < 4.8 | 12 |
| p-Isopropyltoluene | < 4.8 | 6 |
| sec-Butylbenzene | < 4.8 | 3 J1 |
| Toluene | < 4.8 | 0.6 J1 |

| 1111B03 | |
|---|---|
| Depth (ft bgs) | 4.5-5 |
| Acetone | 6.7 J |
| Chloroform | 8.2 |
| *cis*-1,2-DCE | 0.78 J |
| Methylene Chloride | 3.2 J |
| PCE | 1.3 J |
| *trans*-1,2-DCE | 0.32 J |
| TCE | 6.9 |

| 1111MW-01 | | | | | | |
|---|---|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 10-10.5 | 15-15.5 | 20-20.5 |
| No VOCs Detected | | | | | | |

| 1111B02 | |
|---|---|
| Depth (ft bgs) | 4.5-5 |
| Acetone | 3.7 J |
| Chloroform | 0.44 J |
| *cis*-1,2-DCE | 0.98 J |
| TCE | 8.8 |

| 1111SB-19 | | |
|---|---|---|
| Depth (ft bgs) | 2 - 3.5 | 4 - 5.5 |
| PCE | < 5.6 | 1 J1 |
| TCE | 2 J1 | 12 |

| 1111B01 | |
|---|---|
| Depth (ft bgs) | 5-5.5 |
| 1,1-DCE | 17 |
| Acetone | 52 |
| Benzene | 5.2 |
| Carbon disulfide | 6.4 J |
| Chloroform | 26 |
| *cis*-1,2-DCE | 240 |
| Ethylbenzene | 1.7 J |
| Methylene Chloride | 10 |
| PCE | 15 |
| Toluene | 3.5 |
| *trans*-1,2-DCE | 71 |
| TCE | 340 |
| VC | 4.1 |

| 1111MW-03 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 2.5-3 (D) | 5-5.5 | 10-10.5 | 15-15.5 | 20-20.5 |
| 1,2,3-TCB | < 1.1 | < 250 | 11 J1 | < 1.2 | < 1.3 | < 1.1 | < 1.1 |
| 1,2-DCB | < 1.1 | < 250 | 7 J1 | < 1.2 | < 1.3 | < 1.1 | < 1.1 |
| 1,3-DCB | < 1.1 | < 250 | 10 | < 1.2 | < 1.3 | < 1.1 | < 1.1 |
| Benzene | < 1.1 | < 250 | < 11 | 0.7 J1 | < 1.3 | < 1.1 | < 1.1 |
| Chloroform | 2.5 | 400 | < 11 | < 1.2 | < 1.3 | < 1.1 | < 1.1 |
| *cis*-1,2-DCE | 4.2 | 840 | 240 | 2.5 | 0.6 J1 | 1 | 0.8 J1 |
| PCE | 3.8 | 960 | 110 | 1 J1 | < 1.3 | < 1.1 | < 1.1 |
| *trans*-1,2-DCE | 2 | 510 | 120 | 1 | < 1.3 | < 1.1 | < 1.1 |
| TCE | 86 | 11600 | 2200 | 21 | 3.7 | 6.2 | 3.2 |

| 1111SB-33 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.5-3.5 | 5.0-6.0 | |
| Methylene Chloride | 2 J1 | 2 J1 | |

| 1111SB-32 | | | |
|---|---|---|---|
| Depth (ft bgs) | 2.0-4.0 | 2.0-4.0 (D) | 5.0-6.0 |
| Methylene Chloride | 2 J1 | 2 J1 | < 5.4 |

| 1111SB-01 | | | | | | |
|---|---|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 10-10.5 | 10-10.5 | 15-15.5 |
| 1,3,5-TMB | < 1.1 | < 1.1 | < 1.1 | 4.3 | < 1.2 | < 1.2 |
| p-Isopropyltoluene | < 1.1 | < 1.1 | < 1.1 | 2 | < 1.2 | < 1.2 |
| sec-Butylbenzene | < 1.1 | < 1.1 | < 1.1 | 2 | < 1.2 | < 1.2 |

## Legend

- Approximate Extent of Contamination Exceeding Residential PRGs
- Approximate Area of Group A, Site 3 Non-Time Critical Removal Action (OHM, 1997b)
- Burn Area
- Soil Boring (OU 4 RI, 1998)
- Soil Boring (OU 5 RI, 2001)
- Soil Boring (OU 5 RI, 2003)
- Groundwater Monitoring Well

**Notes**

| | |
|---|---|
| 81.1 | Results shown in µg/kg |
| <10 | Not detected at indicated value |
| J1 | Estimated Value |
| **70,800** | Bold text indicates compound detected above industrial soil PRG |

N

0 50 100

Scale in Feet

**Figure 5-7**

**Site 1111**
**VOCs Detected in Soil**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

k:\pod\samlos\oe\camppendleton\OU5RI\RiReport\Fig5-7_S1111soilVOCs.dwg

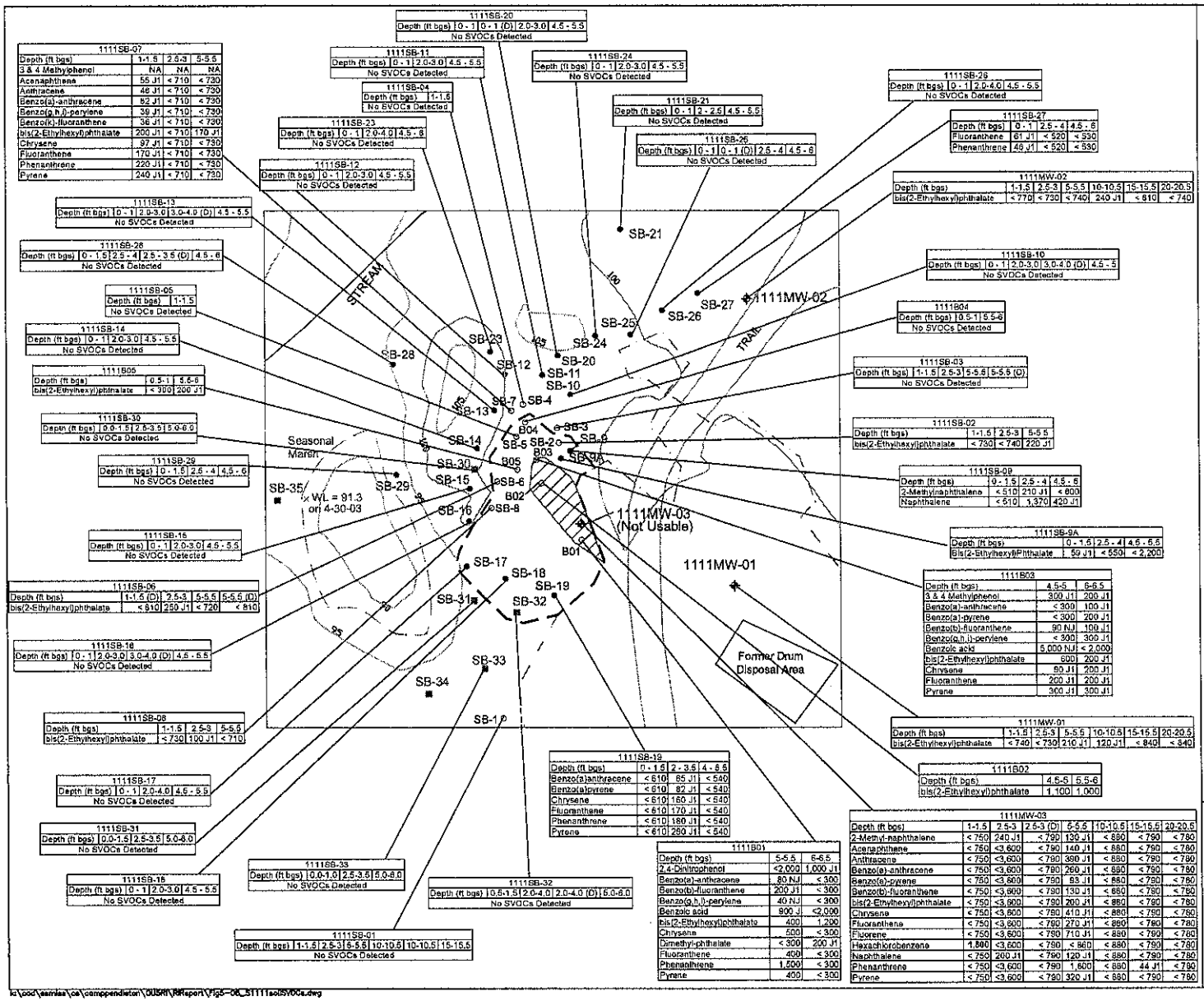
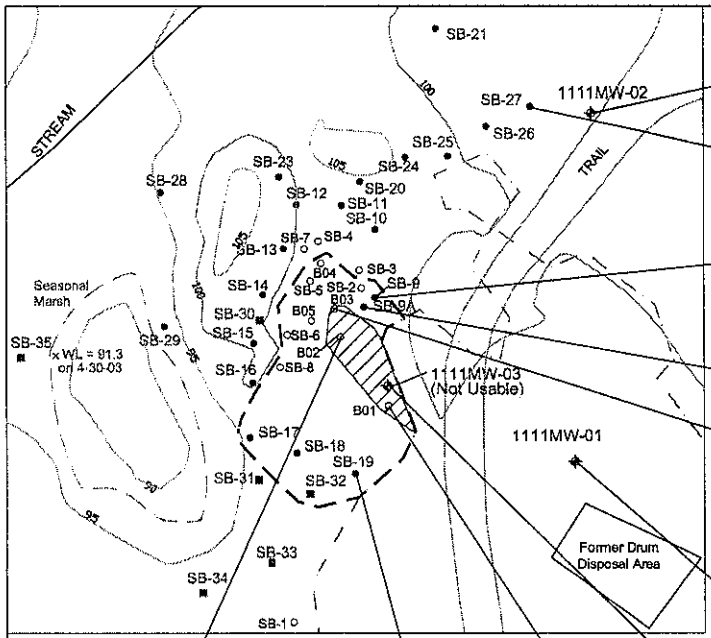



Figure 5-8

Site 1111
SVOCs Detected in Soil

k:\cod\samlas\ca\campendleton\OUSRI\RIReport\Fig5-08_51111soilSVOCs.dwg




| 1111MW-02 | | |
|---|---|---|
| Depth (ft bgs) | 15.0 | 20.0 |
| 2,3,7,8-TCDD Toxicity Equivalents[1] | 1.9 | 1.9 |
| 2,3,7,8-TCDD Toxicity Equivalents[2] | 0.0 | 1.9 |

| 1111SB-27 | |
|---|---|
| Depth (ft bgs) | 0.0 - 1.0 |
| 2,3,7,8-TCDD Toxicity Equivalents[1] | **43.7** |
| 2,3,7,8-TCDD Toxicity Equivalents[2] | 0.0 |

| 1111SB-09 | | |
|---|---|---|
| Depth (ft bgs) | 2.5 - 4.0 | 4.5 - 6.0 |
| 2,3,7,8-TCDD Toxicity Equivalents[1] | **39.2** | **63.0** |
| 2,3,7,8-TCDD Toxicity Equivalents[2] | 0.0 | 0.1 |

| 1111SB-9A | | |
|---|---|---|
| Depth (ft bgs) | 0.0 - 1.5 | 2.5 - 4.0 |
| 2,3,7,8-TCDD Toxicity Equivalents[1] | **75.5** | **98.9** |
| 2,3,7,8-TCDD Toxicity Equivalents[2] | **18.7** | **28.9** |

| 1111B03 | |
|---|---|
| Depth (ft bgs) | 6.0 |
| 2,3,7,8-TCDD Toxicity Equivalents[1] | 4.4 |
| 2,3,7,8-TCDD Toxicity Equivalents[2] | 3.9 |

| 1111MW-01 | | |
|---|---|---|
| Depth (ft bgs) | 15.0 | 20.0 |
| 2,3,7,8-TCDD Toxicity Equivalents[1] | 2.5 | 4.1 |
| 2,3,7,8-TCDD Toxicity Equivalents[2] | 0.5 | 4.1 |

| 1111B02 | |
|---|---|
| Depth (ft bgs) | 4.5 |
| 2,3,7,8-TCDD Toxicity Equivalents[1] | **238.9** |
| 2,3,7,8-TCDD Toxicity Equivalents[2] | **238.9** |

| 1111MW-03 | | | | | | |
|---|---|---|---|---|---|---|
| Depth (ft bgs) | 1.0 | 2.5 | 2.5 | 5.0 | 10.0 | 15.0 |
| 2,3,7,8-TCDD Toxicity Equivalents[1] | **125.2** | **1,393.6** | **42,308.1** | **163.5** | **98.5** | **63.4** |
| 2,3,7,8-TCDD Toxicity Equivalents[2] | **125.2** | **1,393.6** | **42,308.1** | **163.5** | **98.5** | **63.4** |

| 1111SB-19 | |
|---|---|
| Depth (ft bgs) | 2.0 - 3.5 |
| 2,3,7,8-TCDD Toxicity Equivalents[1] | **230.4** |
| 2,3,7,8-TCDD Toxicity Equivalents[2] | **188.6** |

| 1111B01 | |
|---|---|
| Depth (ft bgs) | 5.0 |
| 2,3,7,8-TCDD Toxicity Equivalents[1] | **505.4** |
| 2,3,7,8-TCDD Toxicity Equivalents[2] | **505.4** |

## Legend

- Approximate Extent of Contamination Exceeding Residential PRGs
- Approximate Area of Group A, Site 3 Non-Time Critical Removal Action (OHM, 1997b)
- Burn Area
- Soil Boring (OU 4 RI, 1998)
- Soil Boring (OU 5 RI, 2001)
- Soil Boring (OU 5 RI, 2003)
- Groundwater Monitoring Well

**Notes**

| | |
|---|---|
| 81.1 | Results shown in pg/g |
| <10 | Not detected at indicated value |
| J1 | Estimated Value |
| **230.4** | Bold text indicates compound detected above industrial soil PRG |

1 "Not-detected" congeners are included in the calculation of toxicity equivalents assuming they are present at the reporting limit.

2 "Not-detected" congeners are not included in the calculation of toxicity equivalents.

N

0 50 100

Scale in Feet

**Figure 5-9**

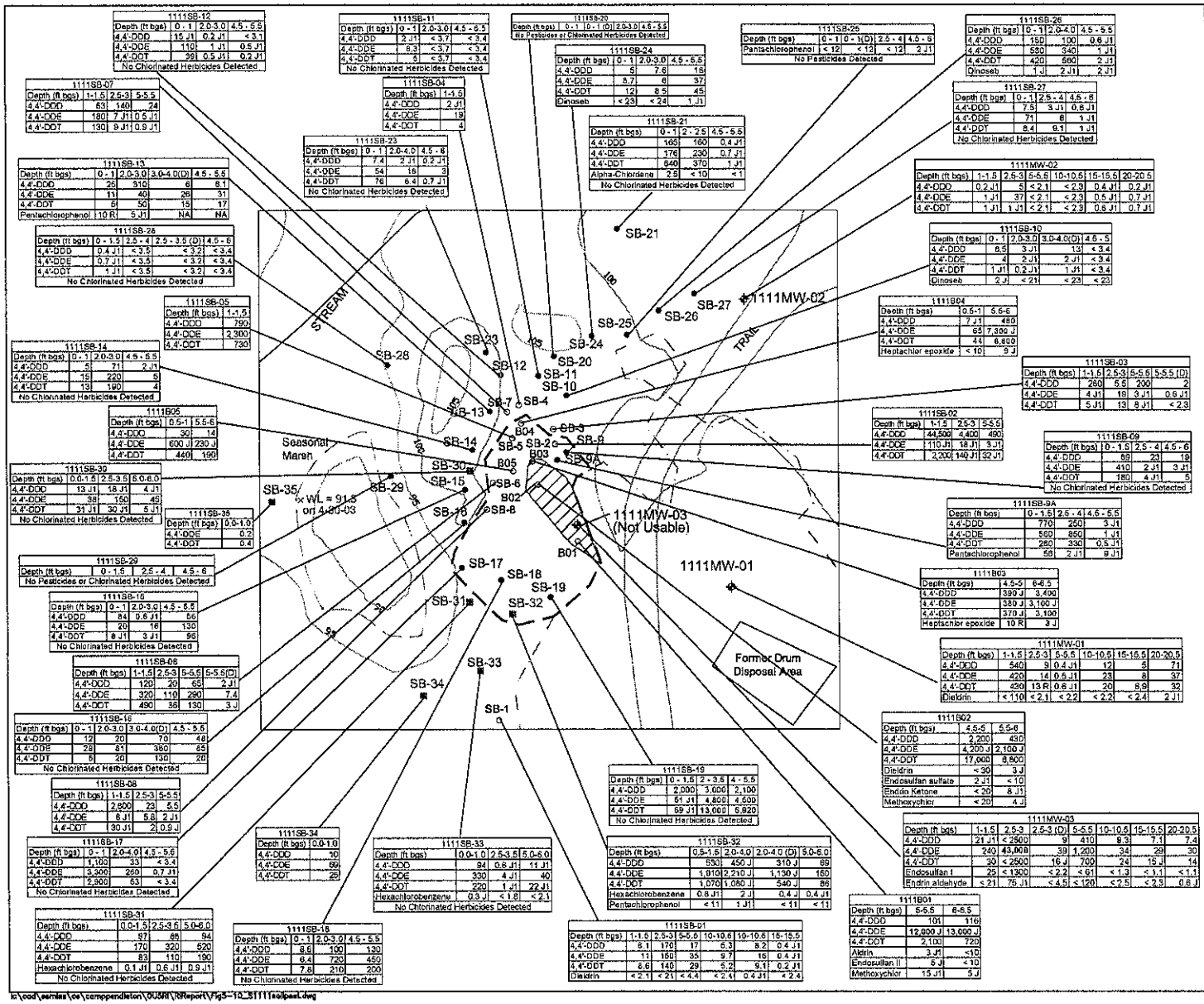
**Site 1111**
**2,3,7,8-TCDD Toxicity Equivalents Results in Soil**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

k:\cad\semiss\ce\camppendleton\OU5RI\RiReport\Fig5-9_S1111soilDioxine.dwg




| 1111SB-12 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 4.5 - 5.5 |
| 4,4'-DDD | 15 J1 | 0.2 J1 | < 3.1 |
| 4,4'-DDE | 110 | 1 J1 | 0.5 J1 |
| 4,4'-DDT | 39 | 0.5 J1 | 0.2 J1 |
| No Chlorinated Herbicides Detected | | | |

| 1111SB-11 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 4.5 - 5.5 |
| 4,4'-DDD | 2 J1 | < 3.7 | < 3.4 |
| 4,4'-DDE | 8.3 | < 3.7 | < 3.4 |
| 4,4'-DDT | 5 | < 3.7 | < 3.4 |
| No Chlorinated Herbicides Detected | | | |

| 1111SB-20 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 0 - 1 (D) | 2.0-3.0 | 4.5 - 5.5 |
| No Pesticides or Chlorinated Herbicides Detected | | | | |

| 1111SB-24 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 4.5 - 5.5 |
| 4,4'-DDD | 5 | 7.6 | 18 |
| 4,4'-DDE | 8.7 | 6 | 37 |
| 4,4'-DDT | 12 | 8.5 | 45 |
| Dinoseb | < 23 | < 24 | 1 J1 |

| 1111SB-25 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 0 - 1 (D) | 2.5 - 4 | 4.5 - 6 |
| Pentachlorophenol | < 12 | < 12 | < 12 | 2 J1 |
| No Pesticides Detected | | | | |

| 1111SB-26 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-4.0 | 4.5 - 5.5 |
| 4,4'-DDD | 150 | 100 | 0.6 J1 |
| 4,4'-DDE | 580 | 340 | 1 J1 |
| 4,4'-DDT | 420 | 560 | 2 J1 |
| Dinoseb | 1 J1 | 2 J1 | 2 J1 |

| 1111SB-07 | | | |
|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 |
| 4,4'-DDD | 63 | 140 | 24 |
| 4,4'-DDE | 180 | 7 J1 | 0.5 J1 |
| 4,4'-DDT | 130 | 9 J1 | 0.9 J1 |

| 1111SB-04 | | |
|---|---|---|
| Depth (ft bgs) | 1-1.5 | |
| 4,4'-DDD | 2 J1 | |
| 4,4'-DDE | 19 | |
| 4,4'-DDT | 4 | |

| 1111SB-21 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2 - 2.5 | 4.5 - 5.5 |
| 4,4'-DDD | 105 | 160 | 0.4 J1 |
| 4,4'-DDE | 176 | 230 | 0.7 J1 |
| 4,4'-DDT | 640 | 370 | 1 J1 |
| Alpha-Chlordane | 2.5 | < 10 | < 1 |
| No Chlorinated Herbicides Detected | | | |

| 1111SB-27 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.5 - 4 | 4.5 - 5 |
| 4,4'-DDD | 7.5 | 3 J1 | 0.5 J1 |
| 4,4'-DDE | 71 | 6 | 1 J1 |
| 4,4'-DDT | 8.4 | 9.1 | 1 J1 |
| No Chlorinated Herbicides Detected | | | |

| 1111SB-23 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-4.0 | 4.5 - 6 |
| 4,4'-DDD | 7.4 | 2 J1 | 0.2 J1 |
| 4,4'-DDE | 54 | 16 | 3 |
| 4,4'-DDT | 76 | 6.4 | 0.7 J1 |
| No Chlorinated Herbicides Detected | | | |

| 1111SB-13 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 3.0-4.0(D) | 4.5 - 5.5 |
| 4,4'-DDD | 26 | 310 | 6 | 8.1 |
| 4,4'-DDE | 11 | 40 | 26 | 31 |
| 4,4'-DDT | 5 | 50 | 15 | 17 |
| Pentachlorophenol | 10 R1 | 5 J1 | NA | NA |

| 1111MW-02 | | | | | | |
|---|---|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 10-10.5 | 15-15.5 | 20-20.5 |
| 4,4'-DDD | 0.2 J1 | 5 | < 2.1 | < 2.3 | 0.4 J1 | 0.2 J1 |
| 4,4'-DDE | 1 J1 | 37 | < 2.1 | < 2.3 | 0.5 J1 | 0.7 J1 |
| 4,4'-DDT | 1 J1 | 1 J1 | < 2.1 | < 2.3 | 0.6 J1 | 0.7 J1 |

| 1111SB-10 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 3.0-4.0(D) | 4.5 - 5 |
| 4,4'-DDD | 6.5 | 3 J1 | 13 | < 3.4 |
| 4,4'-DDE | 4 | 2 J1 | 2 J1 | < 3.4 |
| 4,4'-DDT | 1 J1 | 0.2 J1 | 1 J1 | < 3.4 |
| Dinoseb | 2 J1 | < 21 | < 23 | < 23 |

| 1111SB-28 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0 - 1.5 | 2.5 - 4 | 2.5 - 3.5 (D) | 4.5 - 6 |
| 4,4'-DDD | 0.4 J1 | < 3.5 | < 3.2 | < 3.4 |
| 4,4'-DDE | 0.7 J1 | < 3.5 | < 3.2 | < 3.4 |
| 4,4'-DDT | 1 J1 | < 3.5 | < 3.2 | < 3.4 |
| No Chlorinated Herbicides Detected | | | | |

| 1111SB-05 | |
|---|---|
| Depth (ft bgs) | 1-1.5 |
| 4,4'-DDD | 790 |
| 4,4'-DDE | 2,300 |
| 4,4'-DDT | 730 |

| 1111B04 | | |
|---|---|---|
| Depth (ft bgs) | 0.5-1 | 5.5-6 |
| 4,4'-DDD | 7 J1 | 480 |
| 4,4'-DDE | 65 | 7,300 J |
| 4,4'-DDT | 44 | 6,800 |
| Heptachlor epoxide | < 10 | 5 J |

| 1111SB-14 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 4.5 - 5.5 |
| 4,4'-DDD | 5 | 71 | 2 J1 |
| 4,4'-DDE | 16 | 220 | 5 |
| 4,4'-DDT | 13 | 190 | 4 |
| No Chlorinated Herbicides Detected | | | |

| 1111SB-03 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 5-5.5 (D) |
| 4,4'-DDD | 260 | 5.5 | 200 | 2 |
| 4,4'-DDE | 4 J1 | 18 | 3 J1 | 0.6 J1 |
| 4,4'-DDT | 5 J1 | 13 | 8 J1 | < 2.3 |

| 1111B05 | | |
|---|---|---|
| Depth (ft bgs) | 0.5-1 | 5.5-6 |
| 4,4'-DDD | 30 | 14 |
| 4,4'-DDE | 600 J | 230 J |
| 4,4'-DDT | 440 | 190 |

| 1111SB-02 | | | |
|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 |
| 4,4'-DDD | 44,500 | 4,400 | 490 |
| 4,4'-DDE | 110 J1 | 18 J1 | 5 J1 |
| 4,4'-DDT | 2,200 | 140 J1 | 32 J1 |

| 1111SB-09 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0 - 1.5 | 2.5 - 4 | 4.5 - 6 |
| 4,4'-DDD | 69 | 23 | 19 |
| 4,4'-DDE | 410 | 2 J1 | 3 J1 |
| 4,4'-DDT | 180 | 4 J1 | 5 |
| No Chlorinated Herbicides Detected | | | |

| 1111SB-30 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0-1.5 | 2.5-3.5 | 5.0-6.0 |
| 4,4'-DDD | 13 J1 | 18 J1 | 4 J1 |
| 4,4'-DDE | 38 | 150 | 45 |
| 4,4'-DDT | 31 J1 | 30 J1 | 5 J1 |
| No Chlorinated Herbicides Detected | | | |

| 1111SB-35 | |
|---|---|
| Depth (ft bgs) | 0.0-1.0 |
| 4,4'-DDE | 0.2 |
| 4,4'-DDT | 0.4 |

| 1111SB-9A | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1.5 | 2.5 - 4 | 4.5 - 5.5 |
| 4,4'-DDD | 770 | 250 | 3 J1 |
| 4,4'-DDE | 560 | 850 | 1 J1 |
| 4,4'-DDT | 260 | 330 | 0.5 J1 |
| Pentachlorophenol | 58 | 2 J1 | 8 J1 |

| 1111SB-29 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0 - 1.5 | 2.5 - 4 | 4.5 - 6 |
| No Pesticides or Chlorinated Herbicides Detected | | | |

| 1111B03 | | |
|---|---|---|
| Depth (ft bgs) | 4.5-5 | 6-6.5 |
| 4,4'-DDD | 390 J | 3,400 |
| 4,4'-DDE | 380 J | 3,100 J |
| 4,4'-DDT | 370 J | 3,100 |
| Heptachlor epoxide | 10 R | 3 J |

| 1111SB-16 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 4.5 - 5.5 |
| 4,4'-DDD | 84 | 0.8 J1 | 56 |
| 4,4'-DDE | 20 | 16 | 130 |
| 4,4'-DDT | 8 J1 | 3 J1 | 96 |
| No Chlorinated Herbicides Detected | | | |

| 1111MW-01 | | | | | | |
|---|---|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 10-10.5 | 15-15.5 | 20-20.5 |
| 4,4'-DDD | 540 | 9 | 0.4 J1 | 12 | 5 | 71 |
| 4,4'-DDE | 420 | 14 | 0.5 J1 | 23 | 8 | 37 |
| 4,4'-DDT | 430 | 13 R | 0.6 J1 | 20 | 8.9 | 32 |
| Dieldrin | < 110 | < 2.1 | < 2.2 | < 2.2 | < 2.4 | 2 J1 |

| 1111SB-08 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 5-5.5 (D) |
| 4,4'-DDD | 120 | 20 | 65 | 2 J1 |
| 4,4'-DDE | 320 | 110 | 290 | 7.4 |
| 4,4'-DDT | 490 | 36 | 130 | 3 J |

| 1111B02 | | |
|---|---|---|
| Depth (ft bgs) | 4.5-5 | 5.5-6 |
| 4,4'-DDD | 2,200 | 430 |
| 4,4'-DDE | 4,200 J | 2,100 J |
| 4,4'-DDT | 17,000 | 8,500 |
| Dieldrin | < 90 | 3 J |
| Endosulfan sulfate | 2 J1 | < 10 |
| Endrin Ketone | < 20 | 8 J1 |
| Methoxychlor | < 20 | 4 J |

| 1111SB-19 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1.5 | 2 - 3.5 | 4 - 5.5 |
| 4,4'-DDD | 2,000 | 3,000 | 2,100 |
| 4,4'-DDE | 51 J1 | 4,800 | 4,600 |
| 4,4'-DDT | 69 J1 | 13,000 | 6,920 |
| No Chlorinated Herbicides Detected | | | |

| 1111SB-16 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 3.0-4.0(D) | 4.5 - 5.5 |
| 4,4'-DDD | 12 | 20 | 70 | 48 |
| 4,4'-DDE | 28 | 81 | 380 | 85 |
| 4,4'-DDT | 5 | 20 | 130 | 20 |
| No Chlorinated Herbicides Detected | | | | |

| 1111MW-03 | | | | | | |
|---|---|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 2.5-3 (D) | 5-5.5 | 10-10.5 | 15-15.5 | 20-20.5 |
| 4,4'-DDD | 21 J1 | < 2500 | 9 | 410 | 9.3 | 7.3 | 7.4 |
| 4,4'-DDE | 240 | 43,000 | 39 | 1,200 | 34 | 29 | 30 |
| 4,4'-DDT | 30 | < 2500 | 16 J | 700 | 24 | 15 J | 14 |
| Endosulfan I | 25 | < 1300 | < 2.2 | < 61 | < 1.3 | < 1.1 | < 1.1 |
| Endrin aldehyde | < 21 | 75 J1 | < 4.5 | < 126 | < 2.5 | < 2.3 | 0.8 J |

| 1111SB-08 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 |
| 4,4'-DDD | 2,800 | 23 | 5.5 |
| 4,4'-DDE | 8 J1 | 5.8 | 2 J1 |
| 4,4'-DDT | 30 J1 | 2 | 0.9 J |

| 1111SB-17 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-4.0 | 4.5 - 5.5 |
| 4,4'-DDD | 1,100 | 33 | < 3.4 |
| 4,4'-DDE | 3,300 | 260 | 0.7 J1 |
| 4,4'-DDT | 2,900 | 53 | < 3.4 |
| No Chlorinated Herbicides Detected | | | |

| 1111SB-34 | | |
|---|---|---|
| Depth (ft bgs) | 0.0-1.0 | |
| 4,4'-DDD | 10 | |
| 4,4'-DDE | 66 | |
| 4,4'-DDT | 29 | |

| 1111SB-33 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0-1.0 | 2.5-3.5 | 5.0-6.0 |
| 4,4'-DDD | 94 | 0.8 J1 | 11 J1 |
| 4,4'-DDE | 330 | 4 J1 | 40 |
| 4,4'-DDT | 220 | 1 J1 | 22 J1 |
| Hexachlorobenzene | 0.3 J | < 1.8 | < 2.1 |
| No Chlorinated Herbicides Detected | | | |

| 1111SB-32 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.5-1.5 | 2.0-4.0 | 2.0-4.0 (D) | 5.0-6.0 |
| 4,4'-DDD | 530 | 450 J | 310 J | 89 |
| 4,4'-DDE | 1,910 | 2,210 J | 1,130 J | 160 |
| 4,4'-DDT | 1,070 | 1,080 J | 540 J | 86 |
| Hexachlorobenzene | 0.8 J1 | 2 J | 0.4 J | 0.4 J1 |
| Pentachlorophenol | < 11 | 1 J1 | < 11 | < 11 |

| 1111B01 | | |
|---|---|---|
| Depth (ft bgs) | 5-5.5 | 6-6.5 |
| 4,4'-DDD | 101 | 116 |
| 4,4'-DDE | 12,000 J | 13,000 J |
| 4,4'-DDT | 2,100 | 720 |
| Aldrin | 3 J1 | <10 |
| Endosulfan II | 5 J | < 10 |
| Methoxychlor | 15 J1 | 5 J |

| 1111SB-31 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0-1.5 | 2.5-3.5 | 5.0-6.0 |
| 4,4'-DDD | 97 | 85 | 94 |
| 4,4'-DDE | 170 | 320 | 520 |
| 4,4'-DDT | 83 | 110 | 190 |
| Hexachlorobenzene | 0.1 J1 | 0.6 J1 | 0.9 J1 |
| No Chlorinated Herbicides Detected | | | |

| 1111SB-18 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 4.5 - 5.5 |
| 4,4'-DDD | 8.6 | 100 | 130 |
| 4,4'-DDE | 6.4 | 720 | 450 |
| 4,4'-DDT | 7.8 | 210 | 200 |
| No Chlorinated Herbicides Detected | | | |

| 1111SB-01 | | | | | | |
|---|---|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 10-10.5 | 10-10.5 | 15-15.5 |
| 4,4'-DDD | 8.1 | 170 | 17 | 5.3 | 8.2 | 0.4 J1 |
| 4,4'-DDE | 11 | 160 | 35 | 9.7 | 16 | 0.4 J1 |
| 4,4'-DDT | 8.6 | 140 | 29 | 5.2 | 9.1 | 0.2 J1 |
| Dieldrin | < 2.1 | < 21 | < 4.4 | < 2.4 | 0.4 J1 | < 2.4 |

## Legend

- Approximate Extent of Contamination Exceeding Residential PRGs
- Approximate Area of Group A, Site 3 Non-Time Critical Removal Action (OHM, 1997b)
- Burn Area
- Soil Boring (OU 4 RI, 1998)
- Soil Boring (OU 5 RI, 2001)
- Soil Boring (OU 5 RI, 2003)
- Groundwater Monitoring Well

**Notes**

| | |
|---|---|
| 81.1 | Results shown in µg/kg |
| <10 | Not detected at indicated value |
| J1 | Estimated Value |
| 13,000 | Bold text indicates compound detected above industrial soil PRG |
| | No Chlorinated Herbicides detected in 1998 soil samples |
| | Samples from 1111SB-34 and 1111SB-35 not anavlzed for Chlorinated Herbicides |

N

0 50 100

Scale in Feet

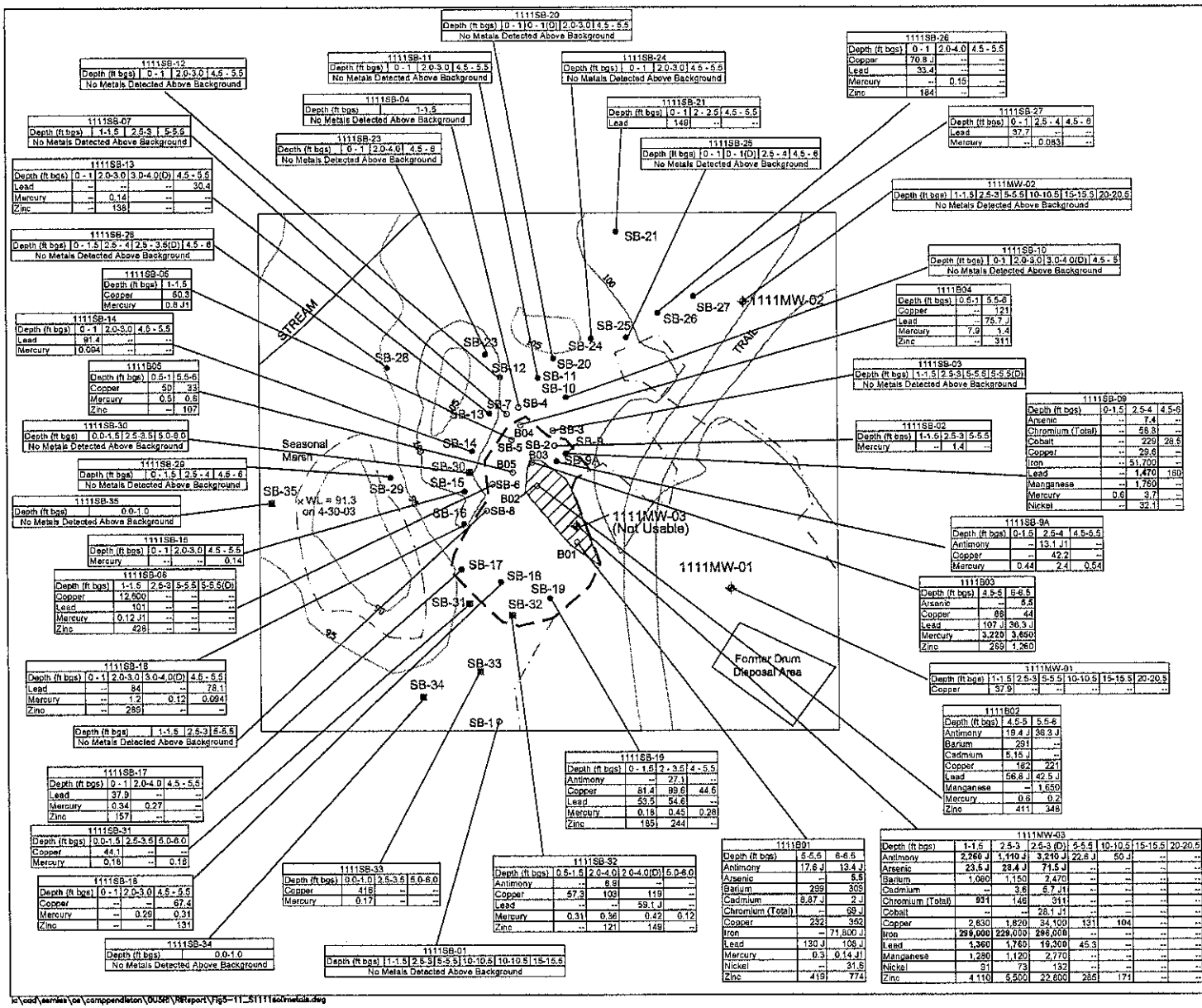
**Figure 5-10**

**Site 1111**
**Pesticides and Chlorinated Herbicides Detected in Soil**

MCB Camp Pendleton, California

PARSONS
Pasadena, CA

k:\cad\series\ce\camppendleton\OU5RI\RiReport\Fig5-10_51111soilpest.dwg




| 1111SB-20 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 0 - 1(D) | 2.0-3.0 | 4.5 - 5.5 |
| No Metals Detected Above Background | | | | |

| 1111SB-12 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 4.5 - 5.5 |
| No Metals Detected Above Background | | | |

| 1111SB-11 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 4.5 - 5.5 |
| No Metals Detected Above Background | | | |

| 1111SB-24 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 4.5 - 5.5 |
| No Metals Detected Above Background | | | |

| 1111SB-26 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-4.0 | 4.5 - 5.5 |
| Copper | 70.8 J | -- | -- |
| Lead | 33.4 | -- | -- |
| Mercury | -- | 0.15 | -- |
| Zinc | 184 | -- | -- |

| 1111SB-04 | |
|---|---|
| Depth (ft bgs) | 1-1.5 |
| No Metals Detected Above Background | |

| 1111SB-21 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2 - 2.5 | 4.5 - 5.5 |
| Lead | 149 | -- | -- |

| 1111SB-27 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.5 - 4 | 4.5 - 6 |
| Lead | 37.7 | -- | -- |
| Mercury | -- | 0.083 | -- |

| 1111SB-07 | | | |
|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 |
| No Metals Detected Above Background | | | |

| 1111SB-23 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-4.0 | 4.5 - 6 |
| No Metals Detected Above Background | | | |

| 1111SB-25 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 0 - 1(D) | 2.5 - 4 | 4.5 - 6 |
| No Metals Detected Above Background | | | | |

| 1111SB-13 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 3.0-4.0(D) | 4.5 - 5.5 |
| Lead | -- | -- | -- | 30.4 |
| Mercury | -- | 0.14 | -- | -- |
| Zinc | -- | 138 | -- | -- |

| 1111MW-02 | | | | | | |
|---|---|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 10-10.5 | 15-15.5 | 20-20.5 |
| No Metals Detected Above Background | | | | | | |

| 1111SB-26 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0 - 1.5 | 2.5 - 4 | 2.5 - 3.5(D) | 4.5 - 6 |
| No Metals Detected Above Background | | | | |

| 1111SB-10 | | | | | |
|---|---|---|---|---|---|
| Depth (ft bgs) | 0-1 | 2.0-3.0 | 3.0-4.0(D) | 4.5 - 5 |
| No Metals Detected Above Background | | | | |

| 1111SB-06 | |
|---|---|
| Depth (ft bgs) | 1-1.5 |
| Copper | 50.3 |
| Mercury | 0.8 J1 |

| 1111B04 | | |
|---|---|---|
| Depth (ft bgs) | 0.5-1 | 5.5-6 |
| Copper | -- | 121 |
| Lead | -- | 75.7 J |
| Mercury | 7.9 | 1.4 |
| Zinc | -- | 311 |

| 1111SB-14 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 4.5 - 5.5 |
| Lead | 91.4 | -- | -- |
| Mercury | 0.094 | -- | -- |

| 1111SB-03 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 5-5.5(D) |
| No Metals Detected Above Background | | | | |

| 1111B05 | | |
|---|---|---|
| Depth (ft bgs) | 0.5-1 | 5.5-6 |
| Copper | 50 | 33 |
| Mercury | 0.5 | 0.8 |
| Zinc | -- | 107 |

| 1111SB-09 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0-1.5 | 2.5-4 | 4.5-6 |
| Arsenic | -- | 7.4 | -- |
| Chromium (Total) | -- | 56.8 | -- |
| Cobalt | -- | 229 | 28.5 |
| Copper | -- | 29.6 | -- |
| Iron | -- | 51,700 | -- |
| Lead | -- | 1,470 | 160 |
| Manganese | -- | 1,760 | -- |
| Mercury | 0.6 | 3.7 | -- |
| Nickel | -- | 32.1 | -- |

| 1111SB-30 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0-1.5 | 2.5-3.5 | 5.0-6.0 |
| No Metals Detected Above Background | | | |

| 1111SB-02 | | | |
|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 |
| Mercury | -- | 1.4 | -- |

| 1111SB-29 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1.5 | 2.5 - 4 | 4.5 - 6 |
| No Metals Detected Above Background | | | |

| 1111SB-35 | |
|---|---|
| Depth (ft bgs) | 0.0-1.0 |
| No Metals Detected Above Background | |

| 1111SB-9A | | | |
|---|---|---|---|
| Depth (ft bgs) | 0-1.5 | 2.5-4 | 4.5-5.5 |
| Antimony | -- | 13.1 J1 | -- |
| Copper | -- | 42.2 | -- |
| Mercury | 0.44 | 2.4 | 0.54 |

| 1111SB-15 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 4.5 - 5.5 |
| Mercury | -- | -- | 0.14 |

| 1111SB-06 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 5-5.5(D) |
| Copper | 12,600 | -- | -- | -- |
| Lead | 101 | -- | -- | -- |
| Mercury | 0.12 J1 | -- | -- | -- |
| Zinc | 428 | -- | -- | -- |

| 1111B03 | | |
|---|---|---|
| Depth (ft bgs) | 4.5-5 | 5-5.5 |
| Arsenic | -- | 5.5 |
| Copper | 88 | 44 |
| Lead | 107 J | 36.3 J |
| Mercury | 3,220 | 3,650 |
| Zinc | 269 | 1,260 |

| 1111SB-18 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-3.0 | 3.0-4.0(D) | 4.5 - 5.5 |
| Lead | -- | 84 | -- | 78.1 |
| Mercury | -- | 1.2 | 0.12 | 0.094 |
| Zinc | -- | 289 | -- | -- |

| 1111MW-01 | | | | | | |
|---|---|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 10-10.5 | 15-15.5 | 20-20.5 |
| Copper | 57.9 | -- | -- | -- | -- | -- |

| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 |
|---|---|---|---|
| No Metals Detected Above Background | | | |

| 1111B02 | | |
|---|---|---|
| Depth (ft bgs) | 4.5-5 | 5.5-6 |
| Antimony | 19.4 J | 36.3 J |
| Barium | 291 | -- |
| Cadmium | 5.15 J | -- |
| Copper | 182 | 221 |
| Lead | 56.8 J | 42.5 J |
| Manganese | -- | 1,650 |
| Mercury | 0.6 | 0.2 |
| Zinc | 411 | 348 |

| 1111SB-17 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1 | 2.0-4.0 | 4.5 - 5.5 |
| Lead | 37.9 | -- | -- |
| Mercury | 0.34 | 0.27 | -- |
| Zinc | 157 | -- | -- |

| 1111SB-19 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0 - 1.5 | 2 - 3.5 | 4 - 5.5 |
| Antimony | -- | 27.1 | -- |
| Copper | 81.4 | 89.6 | 44.6 |
| Lead | 53.5 | 54.6 | -- |
| Mercury | 0.16 | 0.45 | 0.28 |
| Zinc | 165 | 244 | -- |

| 1111SB-31 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0-1.5 | 2.5-3.5 | 5.0-6.0 |
| Copper | 44.1 | -- | -- |
| Mercury | 0.16 | -- | 0.18 |

| 1111SB-33 | | | |
|---|---|---|---|
| Depth (ft bgs) | 0.0-1.0 | 2.5-3.5 | 5.0-6.0 |
| Copper | 415 | -- | -- |
| Mercury | 0.17 | -- | -- |

| 1111SB-32 | | | | |
|---|---|---|---|---|
| Depth (ft bgs) | 0.5-1.5 | 2.0-4.0 | 2.0-4.0(D) | 5.0-6.0 |
| Antimony | -- | 8.8 | -- | -- |
| Copper | 57.3 | 103 | 119 | -- |
| Lead | -- | -- | 59.1 J | -- |
| Mercury | 0.31 | 0.36 | 0.42 | 0.12 |
| Zinc | -- | 121 | 149 | -- |

| 1111B01 | | |
|---|---|---|
| Depth (ft bgs) | 5-5.5 | 6-6.5 |
| Antimony | 17.6 J | 13.4 J |
| Arsenic | -- | 5.5 |
| Barium | 299 | 309 |
| Cadmium | 8.87 J | 2 J |
| Chromium (Total) | -- | 69 J |
| Copper | 232 | 352 |
| Iron | -- | 71,800 J |
| Lead | 130 J | 108 J |
| Mercury | 0.3 | 0.14 J1 |
| Nickel | -- | 31.6 |
| Zinc | 419 | 774 |

| 1111MW-03 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 2.5-3 (D) | 5-5.5 | 10-10.5 | 15-15.5 | 20-20.5 |
| Antimony | 2,260 J | 1,110 J | 3,210 J | 22.8 J | 50 J | -- | -- |
| Arsenic | 23.5 J | 28.4 J | 71.5 J | -- | -- | -- | -- |
| Barium | 1,080 | 1,150 | 2,470 | -- | -- | -- | -- |
| Cadmium | -- | 3.6 | 5.7 J1 | -- | -- | -- | -- |
| Chromium (Total) | 931 | 146 | 311 | -- | -- | -- | -- |
| Cobalt | -- | -- | 28.1 J1 | -- | -- | -- | -- |
| Copper | 2,630 | 1,820 | 34,100 | 131 | 104 | -- | -- |
| Iron | 299,000 | 229,000 | 296,000 | -- | -- | -- | -- |
| Lead | 1,360 | 1,760 | 19,300 | 45.3 | -- | -- | -- |
| Manganese | 1,280 | 1,120 | 2,770 | -- | -- | -- | -- |
| Nickel | 31 | 73 | 132 | -- | -- | -- | -- |
| Zinc | 4,110 | 5,500 | 22,600 | 285 | 171 | -- | -- |

| 1111SB-34 | |
|---|---|
| Depth (ft bgs) | 0.0-1.0 |
| No Metals Detected Above Background | |

| 1111SB-01 | | | | | | |
|---|---|---|---|---|---|---|
| Depth (ft bgs) | 1-1.5 | 2.5-3 | 5-5.5 | 10-10.5 | 10-10.5 | 15-15.5 |
| No Metals Detected Above Background | | | | | | |

## Legend

- Approximate Extent of Contamination Exceeding Residential PRGs
- Approximate Area of Group A, Site 3 Non-Time Critical Removal Action (OHM, 1997b)
- Burn Area
- Soil Boring (OU 4 RI, 1998)
- Soil Boring (OU 5 RI, 2001)
- Soil Boring (OU 5 RI, 2003)
- Groundwater Monitoring Well

**Notes**

For complete list of metals detected, in 1998, see Appendix A in 2001 and 2003, see Table 5-9

| | |
|---|---|
| 61.1 | Results shown in mg/kg |
| -- | Indicates compound not detected above background |
| J | Estimated Value |
| 229,000 | Bold text indicates compound detected above industrial soil PRG |

N

0 50 100

Scale in Feet

**Figure 5-11**

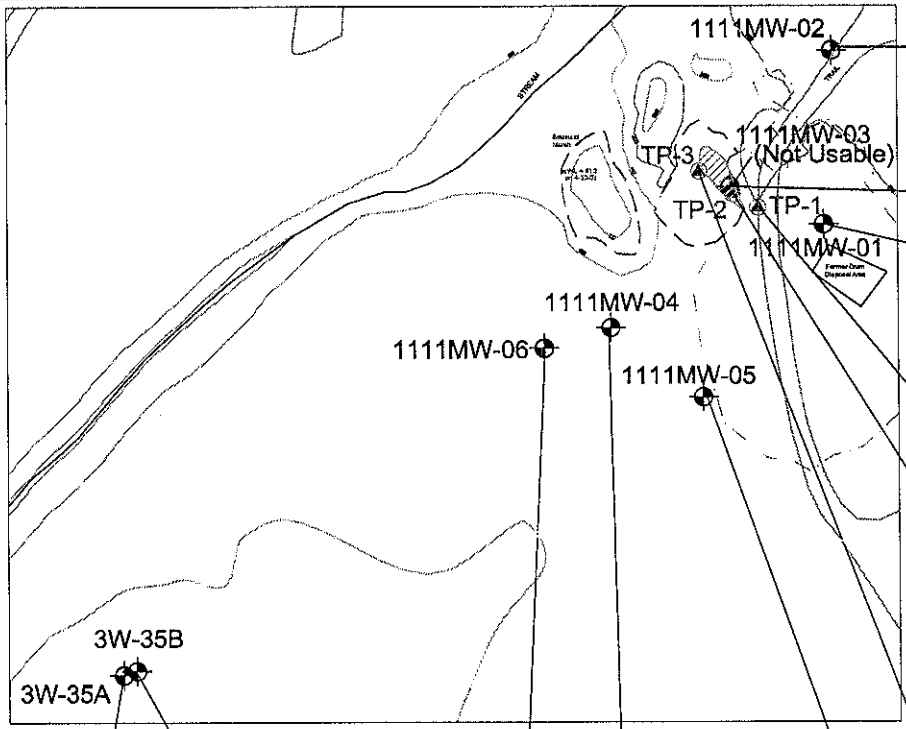
**Site 1111**
**Selected Metals Detected Above Background in Soil**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

i:\cad\semles\ca\camppendleton\OU5RI\RIReport\fig5-11_51111selmetals.dwg




| 1111MW-2 | | | | |
|---|---|---|---|---|
| Date Collected | 12/16/98 | 1/3/02 | 1/3/02 (D) | 3/7/03 |
| Benzene | < 1 | **3.3** | **3.3** | < 0.4 |
| Ethylbenzene | < 1 | 0.4 J1 | 0.4 J1 | < 0.5 |
| m,p-Xylene | < 1 | 0.6 | 0.6 | < 0.5 |
| PCE | < 1 | **5.4** | **5.1** | < 0.5 |
| Toluene | < 1 | 1.1 | 1 | < 0.5 |

| 1111MW-3 | | | | |
|---|---|---|---|---|
| Date Collected | 12/18/98 | 12/18/98(D) | 1/3/02 | 3/7/03 |
| PCE | **24** | **19** | Could Not Sample | |

| 1111MW-1 | | | |
|---|---|---|---|
| Date Collected | 12/16/98 | 1/3/02 | 3/6/03 |
| 1,2,4-Trimethylbenzene | < 1 | 1 | < 0.5 |
| 1,2-DCA | < 1 | **1** | < 0.5 |
| 2-Butanone (MEK) | < 10 | 10 R | 2 J |
| Acetone | < 10 | 50 R | 4 J |
| Benzene | < 1 | **18.1** | < 0.4 |
| Ethylbenzene | < 1 | 2.1 | < 0.5 |
| m,p-Xylene | < 1 | 7.9 | < 0.5 |
| Naphthalene | 3.9 | 0.4 J1 | < 0.4 |
| o-Xylene | < 1 | 3.9 | < 0.5 |
| PCE | **7.3** | 2.1 | < 0.5 |
| TCE | < 1 | 0.5 J1 | < 0.5 |
| Toluene | < 1 | 31.6 | < 0.5 |

| 1111TP-1 | | |
|---|---|---|
| Date Collected | 5/6/98 | 5/6/98(D) |
| 1,1,2-TCA | 0.57 J | 0.56 J |
| Chloroform | 4.1 | 4.3 |
| *cis*-1,2-DCE | 3.5 | 3.5 |
| TCE | **10** | **11** |
| *trans*-1,2-DCE | 0.62 J | 0.5 J |

| 1111TP-2 | |
|---|---|
| Date Collected | 5/6/98 |
| 1,1-DCE | 0.85 J |
| Chloroform | 2.3 |
| *cis*-1,2-DCE | **25** |
| PCE | 1.5 |
| TCE | **35** |
| *trans*-1,2-DCE | 5.4 |

| 1111MW-4 | |
|---|---|
| Date Collected | 1/9/02 |
| Benzene | **1.9** |
| m,p-Xylene | 0.6 |
| PCE | 2.8 |
| TCE | 1 |
| Toluene | 0.7 |

| 3W-35B | | | |
|---|---|---|---|
| Date Collected | 7/28/92 | 3/9/93 | 1/10/02 |
| 1,2,4-Trimethylbenzene | NA | NA | 2.2 J |
| m,p-Xylene | NA | NA | 0.6 J |
| o-Xylene | NA | NA | 3.2 J |
| Total Xylenes | <1 | <1 | NA |

| 3W-35A | | | |
|---|---|---|---|
| Date Collected | 7/28/92 | 2/4/93 | 1/10/02 |
| 1,2,4-Trimethylbenzene | NA | NA | 2.2 J |
| m,p-Xylene | NA | NA | 0.4 J |
| o-Xylene | NA | NA | 3.1 J |
| Total Xylenes | <1 | <1 | NA |

| 1111MW-6 | |
|---|---|
| Date Collected | 1/9/02 |
| Benzene | **1.5** |
| m,p-Xylene | 0.5 |
| PCE | 2.9 |
| TCE | 0.7 |
| Toluene | 0.6 |

| 1111MW-5 | | |
|---|---|---|
| Date Collected | 1/9/02 | 3/7/03 |
| 1,2,4-Trimethylbenzene | 0.7 | < 0.5 |
| 1,2-DCA | **0.7** | < 0.5 |
| Benzene | **8.24** | < 0.4 |
| Ethylbenzene | 1.4 | < 0.5 |
| m,p-Xylene | 5.2 | < 0.5 |
| o-Xylene | 2.6 | < 0.5 |
| PCE | 0.8 | < 0.5 |
| TCE | 1.5 | < 0.5 |
| Toluene | 17.7 | < 0.5 |

| 1111TP-3 | |
|---|---|
| Date Collected | 5/6/98 |
| 1,1,2,2-Tetrachloroethane | **1.7** |
| 1,1,2-TCA | 0.52 J |
| Chloroform | 0.88 |
| *cis*-1,2-DCE | 1.9 |
| TCE | 2.6 |
| *trans*-1,2-DCE | 0.71 J |

**Legend**

- Approximate Extent of Contamination Exceeding Residential PRGs
- Approximate Area of Group A, Site 3 Non-Time Critical Removal Action (OHM, 1997b)
- Burn Area
- Temporary Well (Parsons, 1998)
- Groundwater Monitoring Well

**Notes**

0.34 Results shown in µg/L

4 Bold indicates compound detected above MCL

J or J1 Estimated Value

N

0 100 200

Scale in Feet

**Figure 5-12**

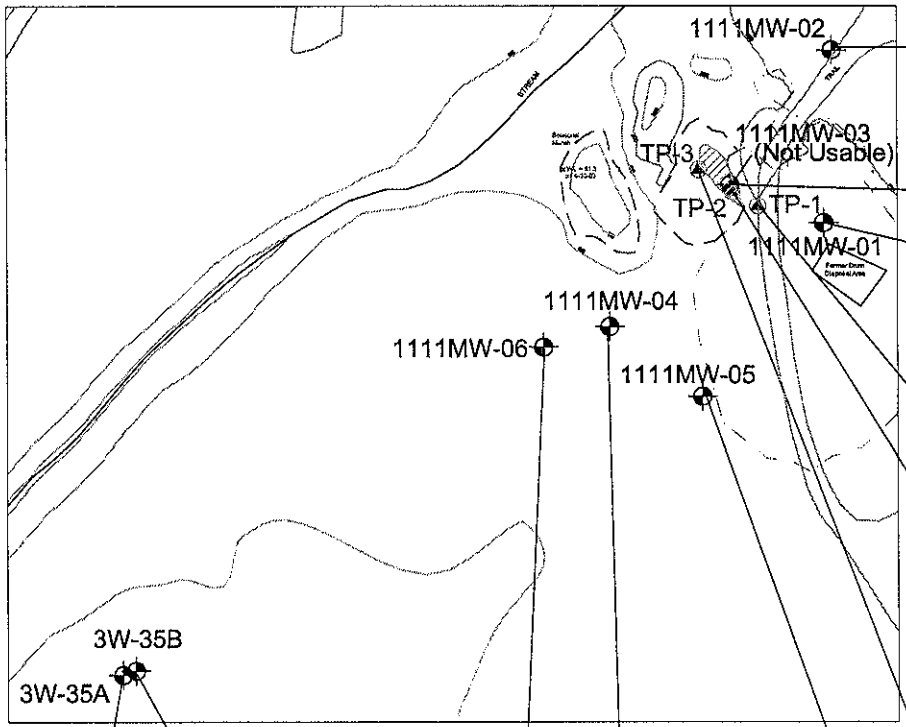
**Site 1111**
**VOCs Detected in Groundwater**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

k:\cad\esmiss\ce\camppendleton\0U5RI\RIReport\Fig5-12_S1111gwVOCs.dwg




| 1111MW-2 | | | | |
|---|---|---|---|---|
| Date Collected | 12/16/98 | 1/3/02 | 1/3/02 (D) | 3/7/03 |
| 2,6-Dinitrotoluene | < 10 | < 10 | 15 | NA |

| 1111MW-3 | | |
|---|---|---|
| Date Collected | 12/16/98 | 12/16/98(D) |
| No SVOCs Detected | | |

| 1111MW-1 | | | |
|---|---|---|---|
| Date Collected | 12/16/98 | 1/3/02 | 3/6/03 |
| Bis(2-Ethylhexyl)Phthalate | 8 J1 | < 3.1 | NA |

| 1111TP-1 | | |
|---|---|---|
| Date Collected | 5/6/98 | 5/6/98(D) |
| bis(2-Ethylhexyl)phthalate | 350 | NA |
| Fluorene | 0.8 J1 | NA |

| 1111TP-2 | |
|---|---|
| Date Collected | 5/6/98 |
| No SVOCs Detected | |

| 1111MW-4 | |
|---|---|
| Date Collected | 1/9/02 |
| No SVOCs Detected | |

| 3W-35B | | | |
|---|---|---|---|
| Date Collected | 7/28/92 | 3/9/93 | 1/10/02 |
| No SVOCs Detected | | | |

| 1111MW-5 | | |
|---|---|---|
| Date Collected | 1/9/02 | 3/7/03 |
| No SVOCs Detected | | |

| 1111MW-6 | |
|---|---|
| Date Collected | 1/9/02 |
| No SVOCs Detected | |

| 3W-35A | | | |
|---|---|---|---|
| Date Collected | 7/28/92 | 2/4/93 | 1/10/02 |
| No SVOCs Detected | | | |

| 1111TP-3 | |
|---|---|
| Date Collected | 5/6/98 |
| No SVOCs Detected | |

**Legend**

- Approximate Extent of Contamination Exceeding Residential PRGs
- Approximate Area of Group A, Site 3 Non-Time Critical Removal Action (OHM, 1997b)
- Burn Area
- Temporary Well (Parsons, 1998)
- Groundwater Monitoring Well

**Notes**

0.34 Results shown in µg/L

J or J1 Estimated Value

N

0 100 200

Scale in Feet

**Figure 5-13**

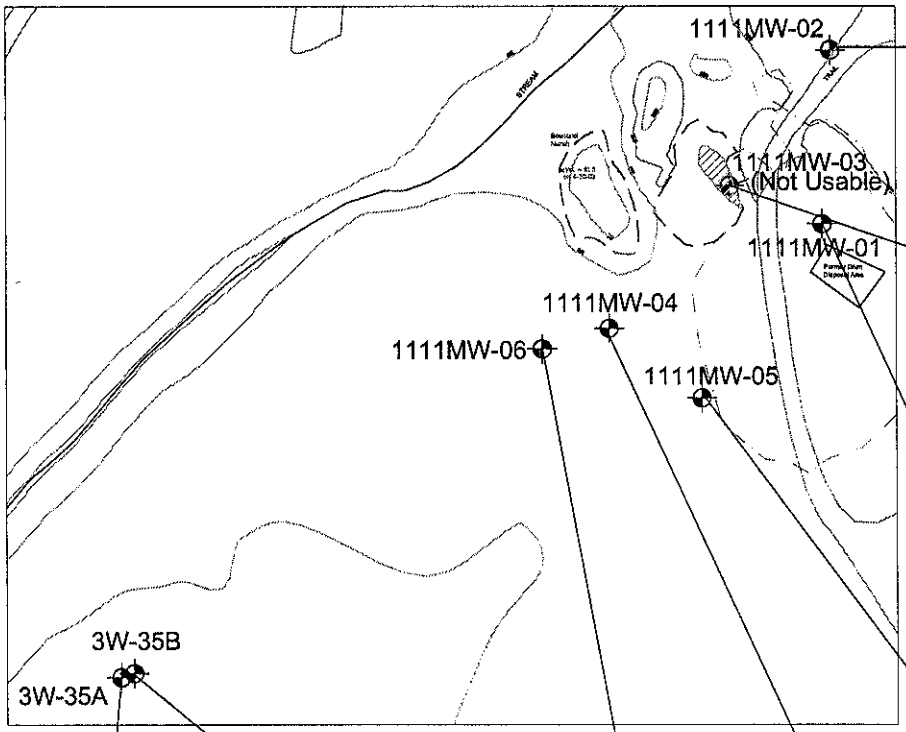
**Site 1111**
**SVOCs Detected in Groundwater**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

k:\cad\eamies\ce\camppendleton\00588\RReport\Fig5-13_51111gwSVOCs.dwg




| 1111MW-2 | | | |
|---|---|---|---|
| Date Collected | 12/16/98 | 1/3/02 | 1/3/02 (D) |
| Arsenic | 0.0024 J1 | 0.0032 J1 | 0.0026 J1 |
| Barium | < 0.0486 | 0.06 | 0.06 |
| Chromium (Total) | < 0.01 | < 0.0021 | 0.0046 J1 |
| Iron | 1.21 | 4 | 4 |
| Manganese | **0.207** | **0.35** | **0.34** |
| Zinc | < 0.0042 | < 0.01 | 0.011 |

| 1111MW-3 | | | | |
|---|---|---|---|---|
| Date Collected | 12/18/98 | 12/18/98(D) | 1/3/02 | 3/7/03 |
| Antimony | 0.0041 J1 | 0.0044 J1 | Could Not Sample | |
| Arsenic | 0.0061 J1 | 0.0068 J1 | | |
| Barium | 0.0708 | 0.0701 | | |
| Chromium (Total) | 0.0012 J1 | 0.0016 J1 | | |
| Iron | 0.793 | 0.747 | | |
| Manganese | **0.321** | **0.324** | | |
| Mercury | < 0.0002 | 0.00024 | | |
| Nickel | 0.0017 J1 | 0.0018 J1 | | |
| Thallium | < 0.01 | 0.003 J1 | | |
| Vanadium | 0.0044 J1 | 0.0043 J1 | | |
| Zinc | 0.0188 J1 | 0.0125 J1 | | |

| 1111MW-1 | | |
|---|---|---|
| Date Collected | 12/16/98 | 1/3/02 |
| Arsenic | 0.0077 J1 | 0.003 J1 |
| Barium | 0.0709 | 0.093 |
| Chromium (Total) | < 0.01 | 0.012 |
| Iron | 1.01 | 3.1 |
| Manganese | **0.339** | **0.34** |
| Zinc | < 0.0035 | 0.015 |

| 1111MW-5 | |
|---|---|
| Date Collected | 1/9/02 |
| Arsenic | 0.0066 |
| Barium | 0.064 |
| Chromium (Total) | 0.0031 J1 |
| Iron | 1.7 |
| Manganese | **0.34** |
| Zinc | 0.011 |

| 3W-35B | |
|---|---|
| Date Collected | 1/10/02 |
| Barium | 0.08 |
| Chromium (Total) | 0.027 |
| Manganese | **0.49** |
| Mercury | 0.00029 |
| Nickel | 0.012 |
| Zinc | 0.018 |

| 1111MW-6 | |
|---|---|
| Date Collected | 1/9/02 |
| Arsenic | 0.034 |
| Barium | 0.097 |
| Chromium (Total) | 0.0071 |
| Iron | 4.4 |
| Manganese | **0.32** |
| Vanadium | 0.0087 J1 |
| Zinc | 0.012 |

| 1111MW-4 | |
|---|---|
| Date Collected | 1/9/02 |
| Antimony | 0.0035 J1 |
| Arsenic | 0.0042 J1 |
| Barium | 0.096 |
| Chromium (Total) | 0.0036 J1 |
| Iron | 3 |
| Manganese | **0.3** |
| Mercury | 0.00031 |
| Zinc | 0.018 |

| 3W-35A | |
|---|---|
| Date Collected | 1/10/02 |
| Barium | 0.062 |
| Chromium (Total) | 0.002 J1 |
| Iron | 0.49 |
| Manganese | **0.4** |
| Mercury | 0.00033 |
| Zinc | 0.025 |

**Legend**

- Approximate Extent of Contamination Exceeding Residential PRGs
- Approximate Area of Group A, Site 3 Non-Time Critical Removal Action (OHM, 1997b)
- Burn Area
- Groundwater Monitoring Well

**Notes**

For complete list of metals detected, for 1998 see Appendix A for 2001 and 2003 see Table 5-17

0.34 Results shown in mg/L

4 Bold indicates compound detected above MCL

J or J1 Estimated Value

N

0 100 200

Scale in Feet

**Figure 5-14**

**Site 1111**
**Selected Metals Detected in Groundwater**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

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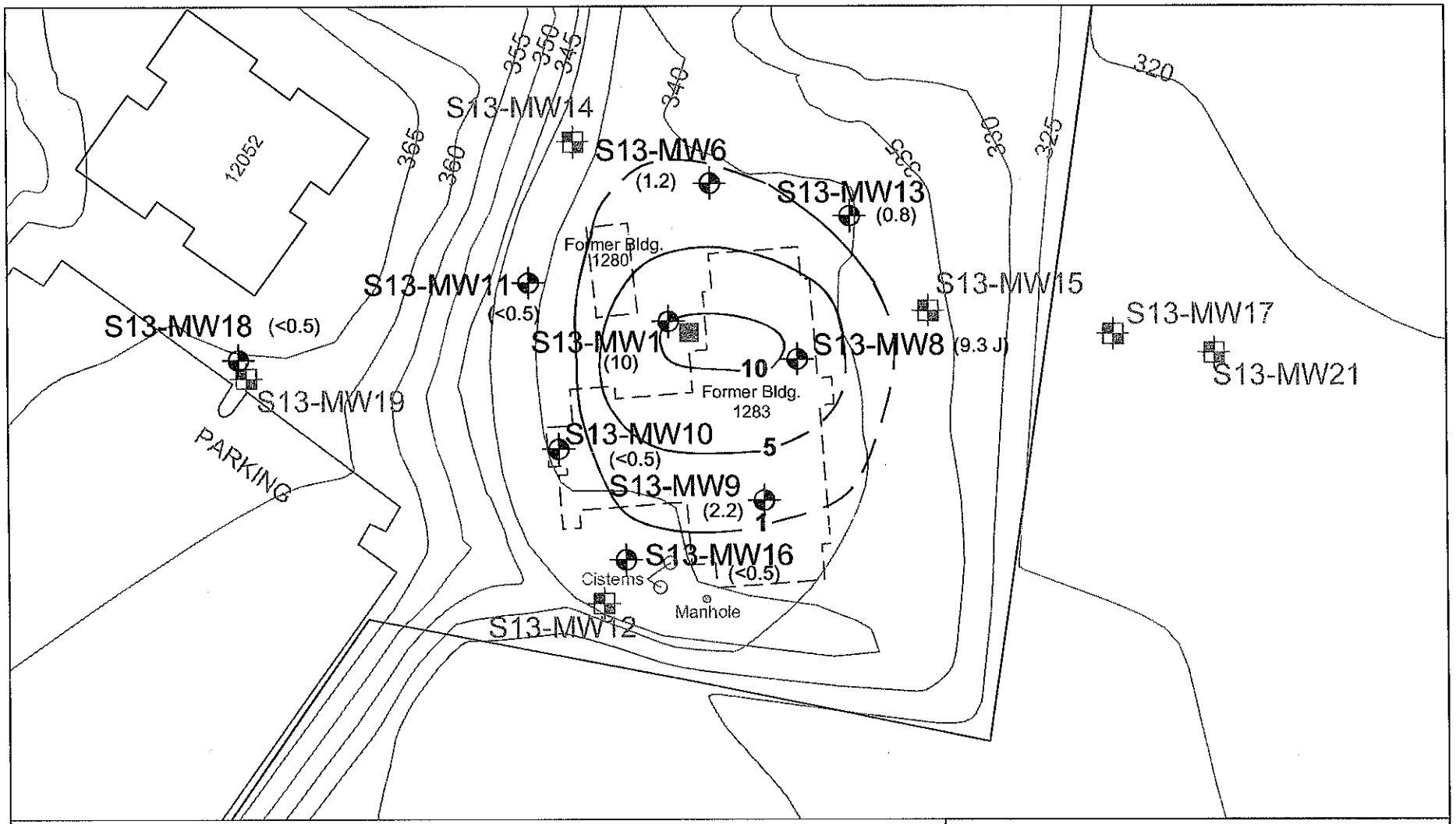
# APPENDIX B3
# 12 AREA, SITE 13




Legend

- Shallow Groundwater Monitoring Well
- Deep Groundwater Monitoring Well
- 1 — TCE Isoconcentration Contour (µg/L) (dashed where inferred)
- (1.2) — TCE Concentration (µg/L)
- (<0.5) — Not detected at referenced detection limit

N

0 80 160

Scale in Feet

**Figure 6-8**

**12 Area, Site 13**
**TCE Detected in**
**Perched Groundwater**
**March 2003**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

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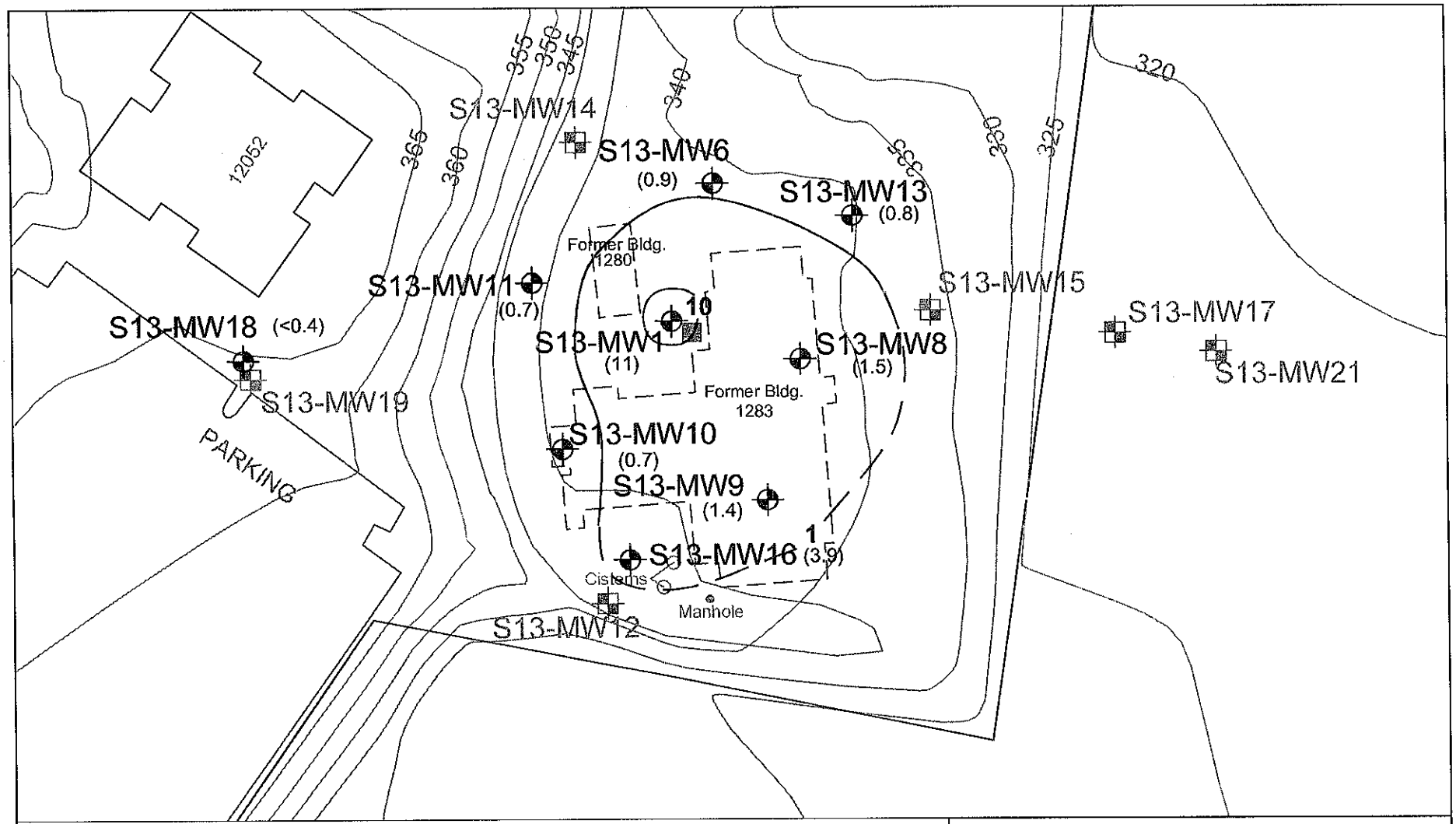


Legend

- Shallow Groundwater Monitoring Well
- Deep Groundwater Monitoring Well
- 1 — 2003 Benzene Isoconcentration Contour (µg/L) (dashed where inferred)
- (1.2) — 2003 Benzene Concentration (µg/L)
- (<0.4) — Not detected at referenced detection limit
- J — Estimated value

N

0 80 160

Scale in Feet

**Figure 6-10**

**12 Area, Site 13**
**Benzene Detected in Perched Groundwater**
**March 2003**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

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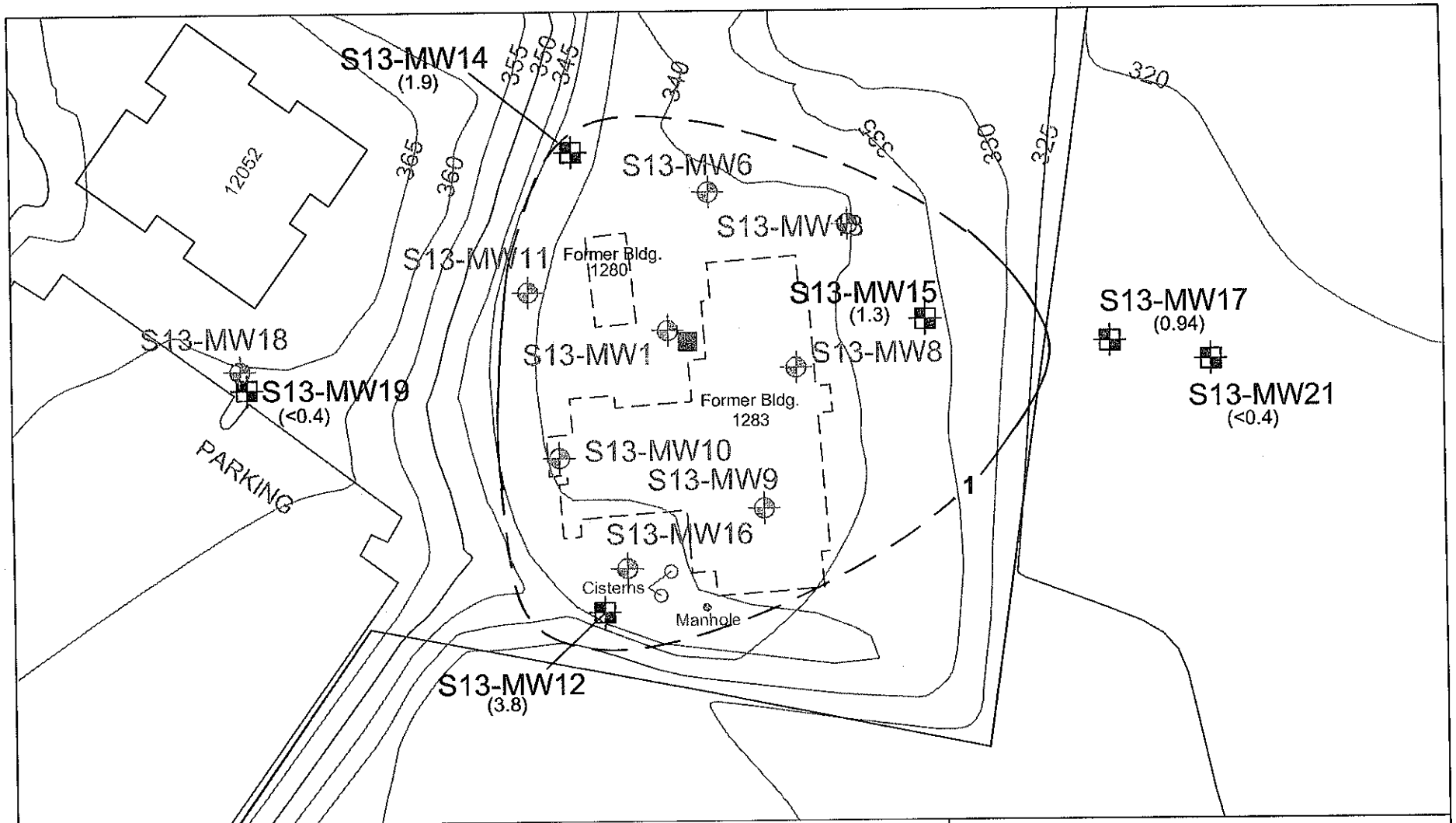


Legend

- Shallow Groundwater Monitoring Well
- Deep Groundwater Monitoring Well
- 1 — 2003 Benzene Isoconcentration Contour (µg/L) (dashed where inferred)
- (1.2) — 2003 Benzene Concentration (µg/L)
- (<0.4) — Not detected at referenced detection limit

N

0 80 160

Scale in Feet

**Figure 6-11**

**12 Area, Site 13**
**Benzene Detected in**
**Deep Groundwater**
**March 2003**

MCB Camp Pendleton, California

**PARSONS**

Pasadena, CA

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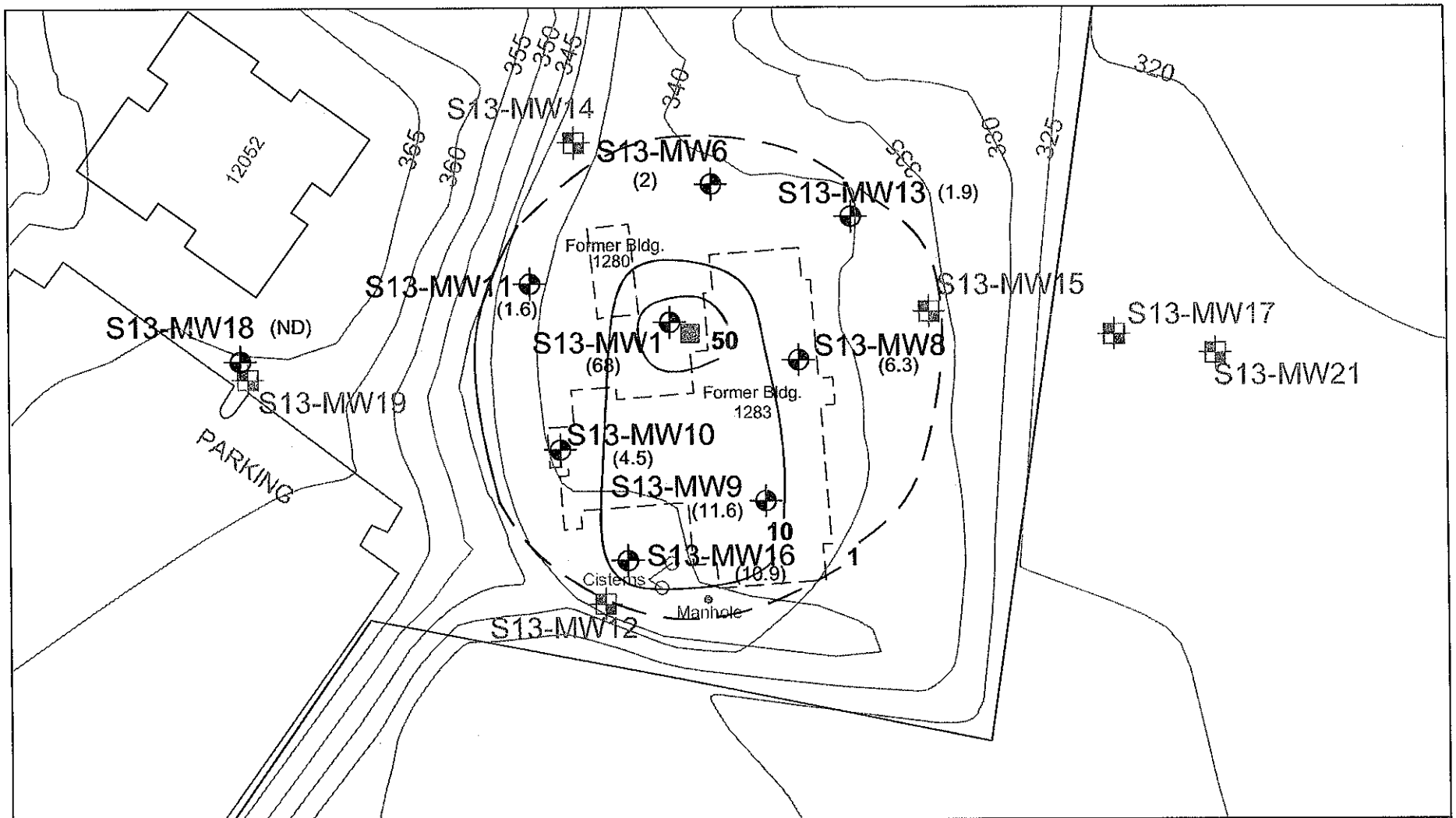


Legend

- Shallow Groundwater Monitoring Well
- Deep Groundwater Monitoring Well
- 1 — 2003 BTEX Isoconcentration Contour (µg/L) (dashed where inferred)
- (1.2) — 2003 BTEX Concentration (µg/L)
- (ND) — Not detected

N

0 80 160

Scale in Feet

**Figure 6-12**

**12 Area, Site 13**
**BTEX Detected in**
**Perched Groundwater**
**March 2003**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

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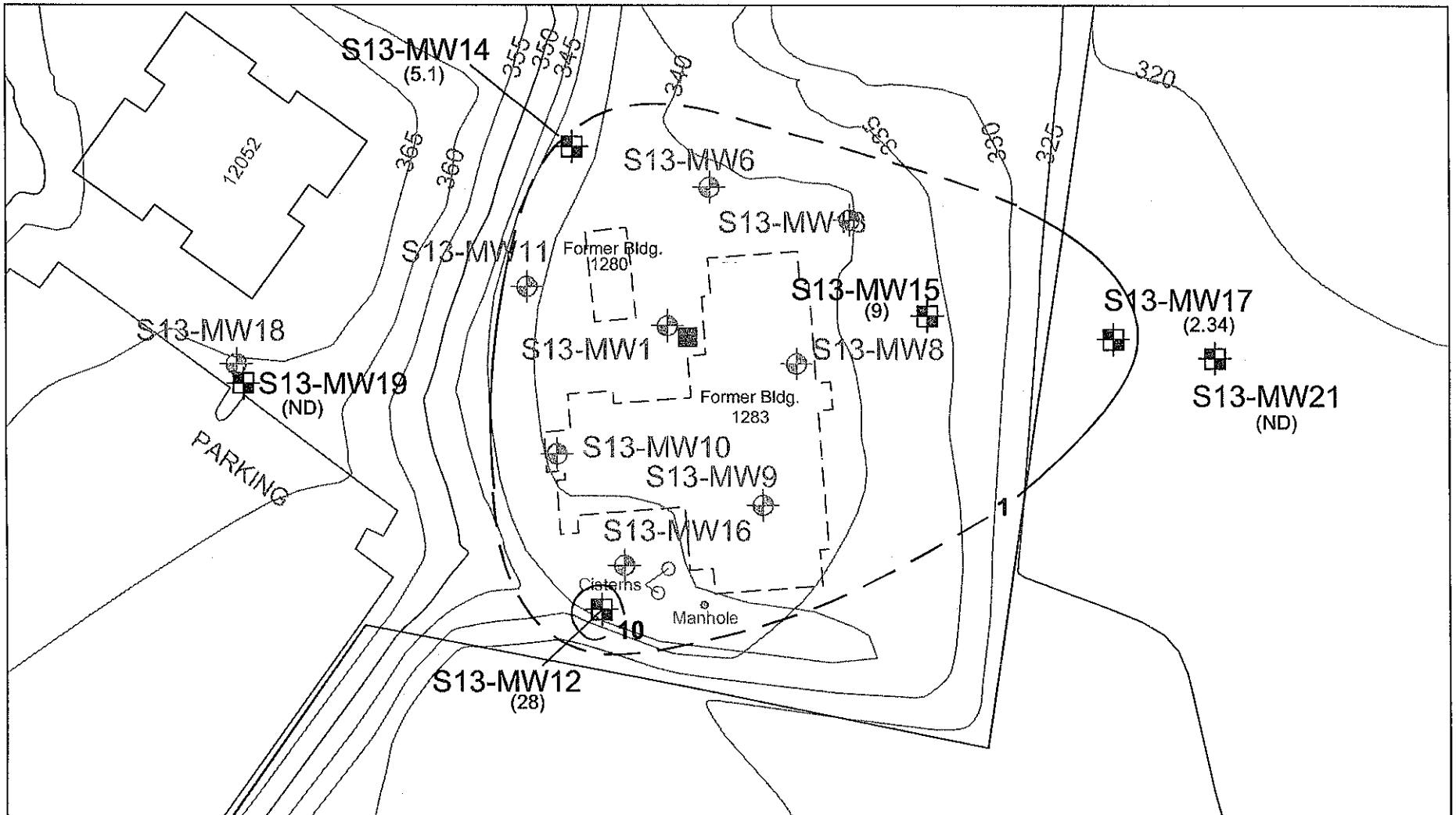


Legend

- Shallow Groundwater Monitoring Well
- Deep Groundwater Monitoring Well
- 1 — BTEX Isoconcentration Contour (µg/L) (dashed where inferred)
- (1.2) — BTEX Concentration (µg/L)
- (<0.5) — Not detected

N

0 80 160

Scale in Feet

**Figure 6-13**

**12 Area, Site 13**
**BTEX Detected in**
**Deep Groundwater**
**March 2003**

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

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# APPENDIX C
# OU 5 SITES SUPPLEMENTAL
# VADOSE ZONE AND GROUNDWATER MODELING

## C1 INTRODUCTION

This appendix presents the results of supplemental vadose zone and groundwater modeling conducted for the OU 5 sites to determine site-specific remedial goals (RGs) that are protective of groundwater beneficial uses, and to evaluate the effectiveness of remedial alternatives to achieve remedial action objectives (RAOs). This evaluation supplements the fate and transport modeling and results presented in Appendix G of the OU 5 RI Report (Parsons, 2004a).

Specifically, the objectives of this supplemental modeling are to:

- Determine RGs for vadose zone soil cleanup of organic contaminants at Sites 1A-1 and 1111 that are protective of groundwater.
- Determine RGs for groundwater cleanup at 12 Area, Site 13. Groundwater underlying this site is classified as non-drinking water sources based on water quality criteria in the San Diego Basin Plan. However, the site is hydraulically connected to the Santa Margarita River Groundwater Basin, which is classified as a drinking water source.
- Estimate the time of remediation (TOR) by natural and enhanced attenuation processes at Site 1111 to restore groundwater quality to below established RGs, with and without source removal. The site is located in the Santa Margarita River Groundwater Basin. Groundwater underlying this site is classified as a drinking water source based on water quality criteria in the San Diego Basin Plan, and subject to drinking water standards.

VLEACH, a vadose zone model (USEPA, 1999), was used in conjunction with SUMMERS (Summers, 1980), a groundwater mixing model, to estimate soil RGs for groundwater protection. BIOCHLOR, a groundwater fate and transport model (USEPA, 2000), was used to evaluate the potential impact of downgradient migration of chlorinated compounds on environmental receptors (e.g., drinking water supply wells, surface water, groundwater basins), and to determine site-specific groundwater RGs. Finally, the Natural Attenuation Software (NAS) model (USGS, 2003) was used to evaluate the effectiveness of natural attenuation processes to reduce fuel and chlorinated solvent concentrations in groundwater and to achieve RAOs. The NAS is designed to estimate the TOR to achieve site-specific groundwater RGs in an impacted aquifer.

Detailed technical documentation for the VLEACH and BIOCHLOR models is provided extensively in Appendix G of the OU 5 RI Report (Parsons, 2004a) and is not included in this appendix. Site-specific conceptual models of the subsurface environment, groundwater flow-system behavior, and contaminant distribution at the OU 5 sites are also discussed in detail in the RI Report and are only discussed here as pertinent. Brief conceptual descriptions of the SUMMERS and NAS models are included as appropriate to document input parameters, calculations, and modeling assumptions.

## C2 VLEACH/SUMMERS MODELING

VLEACH modeling was initially conducted for all organic contaminants at Sites 1A-1 and 1111 that failed the designated level methodology (DLM) (RWQCB, 1989) screening during the OU 5 RI. VLEACH was used to determine the maximum leachate concentrations of each contaminant that could impact groundwater under current site conditions. Soil contaminant concentrations were distributed in the model according to the spatial distribution of actual site environmental samples. The maximum soil concentration of each contaminant detected in a soil depth interval was used in the model for the entire interval to represent worst-case conditions for each site. The depth range for a specific concentration was determined based on the available data. The VLEACH model conservatively assumes no dispersion, degradation, or formation of by-products, and therefore tends to over estimate actual leachate concentrations.

Site-specific maximum allowable leachate concentrations (MALC) for groundwater protection were determined for each contaminant using SUMMERS (Summers, 1980). SUMMERS is a screening-level spreadsheet for estimating soil cleanup levels. The model was developed to estimate when contaminant concentrations in the soil will produce aquifer contaminant concentrations above acceptable levels. The model assumes that a percentage of rainfall at a site infiltrates and desorbs contaminants from the soil based on equilibrium soil-water partitioning. Using a mass balance approach and assuming equilibrated, complete mixing in the aquifer, the soil cleanup level is calculated from the original soil concentration, the concentration of the infiltrating water, and an equilibrium coefficient. The resulting soil concentrations can then be used as guidelines in estimating boundaries or extent of soil contamination by applying the derived maximum soil contaminant concentration level to the observed concentration in the soil at the site.

VLEACH and SUMMERS are used together to estimate the magnitude and duration of any impact to groundwater from the leaching of vadose zone contaminants, and to determine if the resulting concentrations in groundwater would meet or exceed applicable regulatory standards (i.e., MCLs or risk-based levels). The most stringent of the Federal and California drinking water maximum contaminant levels (MCLs) for each contaminant were selected as water quality goals for both of these sites since they are located in the Santa Margarita Groundwater Basin, designated for beneficial use as a drinking water source. USEPA Region 9 tap water preliminary remediation goals (PRGs) were used in the absence of MCLs. These water quality goals were used for all the modeling evaluations.

The VLEACH/SUMMERS evaluations were used to identify soil contaminants that require mitigation or appropriate containment in order to meet groundwater quality goals, and to determine site-specific soil RGs for each contaminant. The results of these evaluations for Sites 1A-1 and 1111 are presented in the following sections.

Site 1A-1

Based on the DLM screening evaluation conducted in the OU 5 RI, all five organic compounds (benzene, chrysene, DDT/DDD/DDE, hexachlorobenzene, and PCBs) that

failed DLM at Site 1A-1 were initially evaluated using VLEACH. The maximum soil concentrations of each contaminant, detected mostly in soil boring 1A1B-01, were used in the evaluations. The maximum concentrations of DDD, DDE, and DDT were added together and modeled as DDT (the most mobile). Because there is no groundwater directly underlying the majority of the waste at Site 1A-1, the potential contaminant migration pathway is along the bedrock surface to the groundwater in the Pilgrim Creek stream channel. Groundwater was conservatively assumed to exist at the bedrock surface. However, no contaminants have been detected in downgradient well 1A1MW-1 located in the stream channel.

The VLEACH soil profile, physical domain, and input parameters for Site 1A-1 are discussed in detail in the OU 5 RI Report and are not repeated here. The SUMMERS groundwater mixing model calculations for the five contaminants evaluated are presented in Tables C-1 through C-5. The model uses VLEACH input parameters and source area dimensions to calculate the downward seepage velocity and volumetric flow rate of leachate into the aquifer, and the site-specific Darcy velocity and volumetric flow rate of groundwater. Assuming equilibrated, complete mixing in the aquifer, SUMMERS calculated soil cleanup levels for each contaminant from the original soil concentration, the leachate concentration, and the soil water partition equilibrium coefficient (Kd). Table C-6 summarizes the Kd calculations for each contaminant evaluated at Site 1A-1. The SUMMERS calculated Kd values were adjusted as necessary to calibrate the model to the VLEACH results.

The results of the VLEACH/SUMMERS evaluations for Site 1A-1 are summarized in Table C-7. As shown in this table, none of the five contaminants evaluated is present in the waste soil at concentrations that exceed their MALCs at the bedrock surface. Therefore, Site 1A-1 does not pose a threat to groundwater under current conditions. Average soil RGs for groundwater protection are presented in Table C-7. Note that two of the contaminants, benzene and DDD/DDE/DDT, are present in a few locations at a maximum soil concentration that exceeds the average soil RG, even though they do not exceed their MALCs. To address this condition, alternate depth-specific soil RGs were determined to take into account the actual contaminant distribution and depth in these locations. The maximum contaminant concentrations at each depth interval were used. The results of these evaluations are presented in Table C-8. This table provides significantly higher than average soil RGs that can be applied for shallower depths when using alternate depth-specific soil RGs.

Tables C-7 and C-8 also estimate the percent reduction from the maximum soil concentrations that would be achieved as a result of implementing the average soil RGs at Site 1A-1.

Site 1111

Based on the DLM screening evaluation conducted in the OU 5 RI, all 17 organic compounds (seven VOCs, seven SVOCs, and three pesticides) that failed DLM at Site 1111 were initially evaluated using VLEACH. The maximum soil concentrations of these contaminants were used in the evaluations. The maximum concentrations of DDD, DDE, and DDT were added together and modeled as DDT (the most mobile). Site 1111

is situated on the unconsolidated alluvium of the Santa Margarita River basin. Groundwater underlying the site is classified as a potential source of drinking water in the San Diego Basin Plan. The presence of a burn layer extending down to the groundwater table poses a direct threat to groundwater. Various organic and inorganic compounds are present in site groundwater above tap water PRGs and MCLs.

The maximum soil concentrations of these contaminants, detected in soil boring 1111SB-09 located at the edge of the burn layer area, were used in the simulations.

VLEACH simulates contaminant leachate concentrations reaching groundwater each year over the simulation period. The VLEACH soil profile, physical domain, and input parameters for Site 1111 are discussed in detail in the OU 5 RI Report and are not repeated here. A vadose zone thickness of 8 feet was determined conservatively based on an average of the highest historical ground water elevations measured in near by monitoring wells. Soil parameters derived from geotechnical soil samples and typical literature values were used to approximate the site's predominant silty/clayey sand conditions. A soil polygon area approximately 20 feet by 60 feet was assumed to represent the burn layer area.

The SUMMERS groundwater mixing model calculations for the 17 contaminants evaluated at Site 1111 are presented in Tables C-9 through C-25. The model uses VLEACH input parameters and source area dimensions to calculate the downward seepage velocity and volumetric flow rate of leachate into the aquifer, and the site-specific Darcy velocity and volumetric flow rate of groundwater. Assuming equilibrated, complete mixing in the aquifer, SUMMERS calculated soil cleanup levels for each contaminant from the original soil concentration, the leachate concentration, and the soil water partition equilibrium coefficient (Kd). Table C-26 summarizes the Kd calculations for each contaminant evaluated at Site 1111. The SUMMERS calculated Kd values were adjusted slightly as necessary to calibrate the model to the VLEACH results.

The results of the VLEACH/SUMMERS evaluations for Site 1111 are summarized in Table C-27. As shown in this table, nine of the 17 organic contaminants evaluated are present in the waste soil at concentrations that exceed their MALCs to groundwater. Therefore, these contaminants pose a direct threat to groundwater underlying Site 1111 under the current conditions. The average soil RGs for groundwater protection for all 17 contaminants evaluated are also presented in Table C-27. The maximum soil concentrations of all nine contaminants that exceeded their MALCs also exceed their average soil RGs. Table C-27 also estimates the percent reduction from the maximum soil concentrations that would be achieved as a result of implementing the average soil RGs at Site 1111.

## C3 BIOCHLOR MODELING

BIOCHLOR modeling was performed as part of this supplemental evaluation for 12 Area, Site 13 to determine groundwater RGs that comply with the beneficial uses and water quality objectives of the Santa Margarita River Groundwater basins (San Diego Region Water Quality Basin Plan). Groundwater underlying the 12 Area, Site 13 is not considered a potential drinking water source due to the presence of high TDS and low

sustainable yields. Therefore, drinking water standards do not apply for these sites. However, they do apply for protection of the beneficial use of the Santa Margarita Groundwater basin.

BIOCHLOR simulates the biodegradation and transport of dissolved chlorinated solvents in groundwater (USEPA, 2000 and 2002). The model is based on the Domenico analytical solute transport model and has the ability to simulate 1-D advection, 3-D dispersion, linear adsorption, and biotransformation via reductive dechlorination (the dominant biotransformation process at most chlorinated solvent sites). Reductive dechlorination is assumed to occur under anaerobic conditions and dissolved solvent degradation is assumed to follow a sequential first-order decay process. BIOCHLOR assumes simple groundwater flow conditions and conservatively approximates the more complicated fate and transport processes that occur in the field.

Input data for the BIOCHLOR model are used to specify or calculate groundwater velocity, aquifer dispersivity, retardation factors, chemical-specific decay coefficients, dissolved contaminant concentrations in the source area, a half-life of the source, and the dimensions of the source zone. Input parameters for the model were determined from site-specific data and commonly accepted literature values and are based on average or representative values. Reasonable simplifying assumptions (e.g., uniform one-dimensional ground-water flow, a vertical plane source, first order decay) are made to generally approximate site conditions.

The BIOCHLOR hydrogeological domain and input parameters, groundwater geochemical characteristics, and contaminant distribution in groundwater over time and space for Sites 1111 and 12 Area, Site 13 are discussed in detail in the OU 5 RI Report and are not repeated here. Detailed technical documentation on the BIOCHLOR model can be found in the BIOCHLOR User's Manual (Version 1.0) (USEPA, 2000) and the User's Manual Addendum (Version 2.2) (USEPA, 2002). The application and results of the BIOCHLOR model for determining groundwater cleanup RGs at these sites are discussed below.

<u>12 Area, Site 13</u>

TCE has been consistently detected at low concentrations in the shallow groundwater at 12 Area, Site 13 since 1995. The shallow groundwater is discontinuous or perched across the site, and is non-existent on the eastern portion of the site. The highest concentrations are present in well S13-MW1 near the source area and in well S13-MW8, located about 75 feet downgradient. TCE concentrations in these wells have remained relatively unchanged during this time fluctuating in a narrow range between 5.6 µg/L and 16 µg/L. No other CAHs have been detected in groundwater at the site, suggesting that measurable biodegradation activity is not taking place.

The TCE plume extends about 100 feet cross gradient of the source in both directions, to the north (wells S13-MW6 and S13-MW13) and to the south (well S13-MW9) of the source, dropping rapidly to below MCL levels (2.2 µg/L to below detection limits). The plume appears to end approximately 300 feet downgradient east of the source area near deep wells S13-MW17 and S13–MW21. Steeper groundwater gradients and the

absence of perched conditions in this area suggest that the perched groundwater merges or infiltrates into the deep groundwater, which generally flows to the west in the opposite direction. TCE was detected at trace levels in four deep groundwater wells in December 2001, but was not detected in any of the wells in March 2003. TCE trace detections in deep wells are likely the result of vertical migration from impacted shallow groundwater.

TCE contamination merging or infiltrating into the deep groundwater zone could conceivably but not likely migrate to Lake O'Neill, approximately 5,900 feet downgradient of the site. Lake O'Neill is the point of entry to the Santa Margarita River Groundwater basin. Assuming there is an existing groundwater pathway, the time for groundwater to travel from Site 13 to Lake O'Neill is conservatively estimated to be about 38 years (i.e., 157 ft/year).

No contamination has been detected in deep well S13-MW19, the most downgradient deep well to the west of the site. Based on its downgradient location, this well is suitable for use as a sentry (early warning) well for the purpose of monitoring potential off-site migration towards Lake O'Neill. Tables C-28 and C-29 summarize the results of multiple BIOCHLOR evaluations performed to determine TCE concentrations at the point of compliance (i.e., Lake O'Neill), resulting from an initial concentration in sentry monitoring well S13-MW19. As shown in Tables C-28 and C-29, a TCE concentration of 50 µg/L detected in well S13-MW19 would result in corresponding concentrations at Lake O'Neill above 5 µg/L (i.e., MCL) in about 50 years and above 0.5 µg/L (i.e., background) in about 41 years, conservatively assuming no degradation. Based on this evaluation, a 50 µg/L RG for TCE in groundwater at 12 Area, Site 13 is considered protective of the Santa Margarita Groundwater basin and would meet the site RAOs. Actual TCE concentrations in groundwater at 12 Area, Site 13 are well below the 50 µg/L RG.

## C4 NATURAL ATTENUATION SOFTWARE (NAS) MODELING

NAS is designed to calculate estimates for the period of time required to achieve site-specific RGs at sites contaminated with either fuels or chlorinated solvents (Brauner, J.S et al., 2001). NAS was used for this evaluation to estimate the time of remediation (TOR) by natural attenuation processes to reduce chlorinated compound concentrations in groundwater at Site 1111 to regulatory-acceptable levels or RGs. Site 1111 is located within the Santa Margarita River Groundwater Basin. Groundwater underlying the site is designated as a potential drinking water source in the San Diego Basin Plan, and drinking water standards do apply for groundwater cleanup and for protection of the beneficial uses of the Santa Margarita Groundwater Basin. The TOR is defined as the time required to lower contaminant mass below the established RG.

NAS is designed to determine the rate at which natural degradation processes (hydrodynamic dispersion, advection, sorption, and biodegradation) remove contaminant mass in groundwater systems (USGS, 2002). This rate is determined by NAS through a mass balance equation, given by the sum of the processes that contribute to natural attenuation. These processes can be summed mathematically to give overall concentration changes of a contaminant over time. NAS assumes that groundwater flow is uniform and one-dimensional. NAS uses site characterization data to calculate the

natural attenuation capacity (NAC) of the aquifer for the various contaminants at a site. Using the NAC estimate and contaminant source data, NAS can be used to evaluate the effects of source reduction or complete removal on TOR estimates, in terms of meeting RGs at a specific point of compliance. NAS calculates the maximum source-area concentration that can be allowed based on a regulatory maximum concentration level at a given point downgradient of the source.

The hydrogeological domain, groundwater geochemical characteristics, and contaminant distribution in groundwater over time and space for Site 1111 are discussed in detail in the OU 5 RI Report, and are only presented here as necessary to document the application of NAS. Table C-30 outlines the minimum data requirements for NAS. Detailed technical documentation on the NAS model can be found in the NAS User's Guide (Brauner J.S., 2001) and the "Methodology for Determining Times of Remediation Associated with MNA" (USGS, 2003). The application and results of the NAS model for determining groundwater cleanup RGs and the TOR for Site 1111 are discussed in the section below.

Site 1111

BIOCHLOR was used during the RI to evaluate the biodegradation and transport of the chlorinated ethenes plume in the aquifer. The BIOCHLOR evaluations indicated that the CAH plume is at a steady state. PCE and TCE concentrations above MCLs have reached a distance of about 200 to 300 feet downgradient of the source. The leading edge of the plume (i.e., above detectable levels, greater than 0.5 µg/L) extends to about 350 to 400 feet. The results of the BIOCHLOR evaluation are presented in detail in the OU 5 RI Report (Parsons, 2004a).

Based on the VLEACH results for Site 1111 presented in Section C2, the source area (i.e., burn layer) in the saturated/unsaturated zone poses a continuous source of contaminants to groundwater. To obtain a reliable estimate of the time required to dissolve and lower contaminant concentrations in the source area to levels below established RGs, an accurate estimate of the VOC mass (i.e., the most mobile fraction) present as nonaqueous phase liquid (NAPL) in the vadose and saturated zones in the source area was developed. The VOC mass calculations for Site 1111 are presented in Table C-31 and summarized in Table C-32. Based on a source area of approximately 60 ft. x 20 ft, an average vadose zone depth of 6 ft., a saturated thickness of 25 ft., and a soil porosity of 0.3, a VOC mass of 171 lbs. (78 kg) was calculated to exist in the vadose zone, versus a VOC mass of only 1.5 lbs (0.55 kg) in the saturated zone (i.e., soil and groundwater). Roughly 99 percent of the total VOC mass is present in the vadose zone and only 1 percent is present in the saturated zone. These estimates are highly conservative since the maximum concentration of each VOC was used in the calculations, and are consistent with previous BIOCHLOR mass calculations during the RI of approximately 0.4 kg of PCE and TCE in the dissolved plume. Note that the estimated total CAH mass, 6 lbs., is only about 4 percent of the total VOC mass; CAHs comprise 84 percent of the 1.5 lbs of VOC mass present in the saturated soil and groundwater. Thus, chlorinated compounds pose the greatest risk of impacting groundwater and migrating away from the source area. The nearest downgradient in-service Base production well, 105/4W-7R2, is located 1,850 feet southwest of the site.

The hydrogeologic, geochemical, and contaminant data for Site 1111 used as input parameters to NAS are summarized in Table C-33. Estimates for hydraulic conductivity, hydraulic gradient, and soil porosity are based on the conceptual site model and BIOCHLOR modeling parameters presented in the OU 5 RI. NAS calculated an average groundwater flow velocity of about 42 feet/year and an estimated plume length of about 260 feet, consistent with the BIOCHLOR results. The site's monitoring well network was used to delineate the CAH plume and to follow contaminant concentration changes over time. As discussed in Appendix G of the OU 5 RI Report (Parsons, 2004a), groundwater data in the source area are very limited. While oxidation/reduction data in the source area are insufficient for NAS to determine the controlling oxidation/reduction condition, the overall data indicate predominantly oxic conditions downgradient with more likely reducing conditions near the source area. Based on the available contaminant concentration data, NAS calculated a single zone average NAC of 0.0169 / ft. and a biodegradation rate of 0.0024 per day for total CAHs. In general, this biodegradation rate is much lower than typical rates observed at anoxic CAH contaminated sites (Wiedemeier et al., 1999).

The maximum source concentration, time-of stabilization (TOS), and TOR calculations performed by NAS are also summarized in Table C-33. Because the maximum target groundwater concentration for total CAHs in the source area is the MCL (5 µg/L), the point of compliance is assumed to be at the water table. Based on the actual source area CAH concentration of 84 µg/L, source reduction is needed at this site. Assuming that soil Alternative 1111-S3 is implemented, all contaminant mass in the vadose zone (~78 kg.) would be excavated. As shown in Tables C-31 and C-32, this would represent about 99 percent of the total estimated contaminant mass in the subsurface. NAS calculations performed to evaluate the TOR by natural attenuation indicate that the TOR for natural processes to dissolve contaminant mass and lower concentrations to below RGs after implementing source removal (assuming 99 percent CAH mass removal) would be approximately 3 years to MCLs and 5 years to background.

## C5 REFERENCES

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## Table C-1. Maximum Allowable Leachate Concentration and Soil Cleanup Level for Benzene - Site 1A-1

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0176 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.234 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 80000 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 329.47 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 60 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 18 | ft/d |
| Ha -- Thickness of aquifer [L]: | 20 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 150 | ft |
| Qa -- Volumetric flow rate of ground water = | 54000 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.001 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 0.21 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.1649 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 0.0346 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.234 | VLEACH volumetric water content (dimensionless) |
| 80000 | VLEACH polygon area ($ft^2$) |
| 0.002 | VLEACH concentration at bottom of polygon ***CLIQ*** ($g/ft^3$) |
| 0.234 | Void Fraction **E** |
| 0.0176 | Seepage Velocity **Vsz** (ft/day) |
| 328.54 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 0.071 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-2. Maximum Allowable Leachate Concentration and Soil Cleanup Level for Chrysene - Site 1A-1

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0176 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.234 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 80000 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 329.47 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 60 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 18 | ft/d |
| Ha -- Thickness of aquifer [L]: | 20 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 150 | ft |
| Qa -- Volumetric flow rate of ground water = | 54000 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.0006 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 200 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.0923 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 18.469 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.234 | VLEACH volumetric water content (dimensionless) |
| 80000 | VLEACH polygon area ($ft^2$) |
| 0.000009 | VLEACH concentration at bottom of polygon ***CLIQ*** ($g/ft^3$) |
| 0.234 | Void Fraction **E** |
| 0.01755033 | Seepage Velocity **Vsz** (ft/day) |
| 328.542094 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 0.0003 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-3. Maximum Allowable Leachate Concentration and Soil Cleanup Level for DDD/DDE/DDT - Site 1A-1

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0176 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.234 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 80000 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 329.47 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 60 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 18 | ft/d |
| Ha -- Thickness of aquifer [L]: | 20 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 150 | ft |
| Qa -- Volumetric flow rate of ground water = | 54000 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.0003 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 635 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.0462 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 29.319 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.234 | VLEACH volumetric water content (dimensionless) |
| 80000 | VLEACH polygon area ($ft^2$) |
| 0.0076 | VLEACH concentration at bottom of polygon ***CLIQ*** ($g/ft^3$) |
| 0.234 | Void Fraction **E** |
| 0.01755033 | Seepage Velocity **Vsz** (ft/day) |
| 328.542094 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 0.27 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-4. Maximum Allowable Leachate Concentration and Soil Cleanup Level for Hexachlorobenzene - Site 1A-1

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0176 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.234 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 80000 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 329.47 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 60 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 18 | ft/d |
| Ha -- Thickness of aquifer [L]: | 20 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 150 | ft |
| Qa -- Volumetric flow rate of ground water = | 54000 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 4E-05 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 55 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.0069 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 0.3809 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.234 | VLEACH volumetric water content (dimensionless) |
| 80000 | VLEACH polygon area ($ft^2$) |
| 0.000001 | VLEACH concentration at bottom of polygon ***CLIQ*** ($g/ft^3$) |
| 0.234 | Void Fraction **E** |
| 0.017550326 | Seepage Velocity **Vsz** (ft/day) |
| 328.5420945 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 0.000035 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-5. Maximum Allowable Leachate Concentration and Soil Cleanup Level for PCBs - Site 1A-1

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0176 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.234 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 80000 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = * | 329.47 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 60 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 18 | ft/d |
| Ha -- Thickness of aquifer [L]: | 20 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 150 | ft |
| Qa -- Volumetric flow rate of ground water = | 54000 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 3E-05 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 306 | ml/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.0056 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 1.7156 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.234 | VLEACH volumetric water content (dimensionless) |
| 80000 | VLEACH polygon area ($ft^2$) |
| 0.000001 | VLEACH concentration at bottom of polygon CLIQ ($g/ft^3$) |
| 0.234 | Void Fraction E |
| 0.017550326 | Seepage Velocity Vsz (ft/day) |
| 328.5420945 | Volumetric Flow Rate Qp ($ft^3/d$) |
| 0.000035 | Leachate Concentration Cp (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-6. Site 1A-1 Contaminant Kd Calculations

| Compound | Groundwater Quality Goal (GWQG) | GWQG Source | Koc | foc | Kd | Adjusted Kd |
|---|---|---|---|---|---|---|
| Benzene | 1.00 ug/L | CA MCL | 65 L/Kg | 0.003 | 0.20 | 0.21 |
| Chrysene | 0.56 ug/L | CMTap water PRG | 200000 L/Kg | 0.003 | 600 | 200 |
| DDT/DDE/DDD | 0.28 ug/L | Tap Water PRG | 178000 L/Kg | 0.003 | 534 | 635 |
| Hexachlorobenzene | 0.04 ug/L | Tap Water PRG | 55300 L/Kg | 0.003 | 166 | 55 |
| PCB 1254/1260 | 0.03 ug/L | Tap Water PRG | 306000 L/Kg | 0.003 | 918 | 306 |

## Table C-7. Site 1A-1 Average Soil Remedial Goals for Groundwater Protection

| Compound | Groundwater Quality Goal (GWQG) | GWQG Source | Maximum Allowed Leachate Concentration[1] | Maximum Leachate Concentration[2] from Actual Conditions | Meets GWQG | Maximum Detected Soil Concentration | Average Soil Removal RG to Meet GWQG | % Reduction in Maximum Soil Concentration |
|---|---|---|---|---|---|---|---|---|
| Benzene | 1.00 ug/L | CA MCL | 165 ug/L | 71.0 ug/L | Yes | **52** ug/Kg | **34** ug/Kg | 34.6% |
| Chrysene | 0.56 ug/L | CMTap water PRG | 92 ug/L | 0.0004 ug/L | Yes | 46 ug/Kg | **18,500** ug/Kg | None |
| DDT/DDE/DDD | 0.28 ug/L | Tap Water PRG | 46 ug/L | 0.270 ug/L | Yes | **321,000** ug/Kg | **29,000** ug/Kg | 91.0% |
| Hexachlorobenzene | 0.04 ug/L | Tap Water PRG | 6.9 ug/L | 0.036 ug/L | Yes | 44 ug/Kg | **380** ug/Kg | None |
| PCB 1254/1260 | 0.03 ug/L | Tap Water PRG | 5.6 ug/L | 0.03 ug/L | Yes | 69 ug/Kg | **1,700** ug/Kg | None |

[1] Maximum allowed leachate concentration in groundwater estimated by Summers Groundwater Mixing Model (USEPA)

[2] Maximum leachate concentration at soil-bedrock interface estimated by VLEACH Vadose Zone Transport Model (USEPA)

## Table C-8. Site 1A-1 Alternate Depth-Specific Soil Remedial Goals for Groundwater Protection

| Compound / Depth | Groundwater Quality Goal (GWQG) | GWQG Source | Maximum Allowed Leachate Concentration[1] | Maximum Leachate Concentration[2] from Actual Conditions | Meets GWQG | Maximum Detected Depth-Specific Soil Concentration | Depth-Specific Soil Removal RG to Meet GWQG | % Reduction in Soil Concentration |
|---|---|---|---|---|---|---|---|---|
| Benzene | 1.00 ug/L | CA MCL | 165 ug/L | 71.0 ug/L | Yes | | | |
| 0-5 ft | | | | | | 52 ug/Kg | **75** ug/Kg | None |
| 5-10 ft | | | | | | 2 ug/Kg | **40** ug/Kg | None |
| 10-15 ft | | | | | | 0 ug/Kg | **15** ug/Kg | None |
| DDT/DDE/DDD | 0.28 ug/L | Tap Water PRG | 46 ug/L | 0.270 ug/L | Yes | | | |
| 0-3 ft | | | | | | 3,524 ug/Kg | **400,000** ug/Kg | None |
| 3-4 ft | | | | | | 321,000 ug/Kg | **400,000** ug/Kg | None |
| 4-5 ft | | | | | | 3,670 ug/Kg | **400,000** ug/Kg | None |
| 5-10 ft | | | | | | 300 ug/Kg | **100,000** ug/Kg | None |
| 10-15 ft | | | | | | 3 ug/Kg | **20,000** ug/Kg | None |

[1] Maximum allowed leachate concentration in groundwater estimated by Summers Groundwater Mixing Model (USEPA)

[2] Maximum leachate concentration at soil-bedrock interface estimated by VLEACH Vadose Zone Transport Model (USEPA)

## Table C-9. Maximum Allowable Leachate Concentration and Soil Cleanup Level for 124-TMB - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.012 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 0.97 | mgi/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.5956 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 0.5777 | mg/kg |

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 1.6 | VLEACH concentration at bottom of polygon ***CLIQ*** ($g/ft^3$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 56.497 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.


(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

## Table C-10. Maximum Allowable Leachate Concentration and Soil Cleanup Level for 135-TMB - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.012 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 0.71 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.5956 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 0.42288 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.552 | VLEACH concentration at bottom of polygon ***CLIQ*** (g/$ft^3$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** ($ft^3$/d) |
| 19.492 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-11. Maximum Allowable Leachate Concentration and Soil Cleanup Level for Chloroform - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.08 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 0.17 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 3.9707 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 0.675 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.021 | VLEACH concentration at bottom of polygon **CLIQ** ($g/ft^3$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 0.74 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-12. Maximum Allowable Leachate Concentration and Soil Cleanup Level for CIS-12DCE - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.006 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 0.17 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.2978 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 0.0506 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.0525 | VLEACH concentration at bottom of polygon ***CLIQ*** ($g/ft^3$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 1.854 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-13. Maximum Allowable Leachate Concentration and Soil Cleanup Level for Methylene Chloride - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.005 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 0.13 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.2482 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 0.0323 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.1561 | VLEACH concentration at bottom of polygon **CLIQ** (g/$ft^2$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** ($ft^3$/d) |
| 5.512 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-14. Maximum Allowable Leachate Concentration and Soil Cleanup Level for Naphthalene - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.0062 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 1.3 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.3077 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 0.4 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.242 | VLEACH concentration at bottom of polygon ***CLIQ*** ($g/ft^3$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 8.545 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-15. Maximum Allowable Leachate Concentration and Soil Cleanup Level for n-Propylbenzene - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | | |
|---|---|---|---|
| Vsz | -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E | -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz | -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap | -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp | -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa | -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea | -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda | -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha | -- Thickness of aquifer [L]: | 25 | ft |
| Wp | -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa | -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca | -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw | -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.24 | mg/l |
| Kd | -- Equilibrium partition coefficent [ml/g]: | 3 | mgl/g |
| Cmax | -- Maximum allowable concentration in the infiltration (leachate) = | 11.912 | mg/l |
| Cs | -- Soil cleanup level (soil concentration) = | 35.736 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.066 | VLEACH concentration at bottom of polygon **CLIQ** ($g/ft^3$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 2.331 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-16. Maximum Allowable Leachate Concentration and Soil Cleanup Level for PCE - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.005 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 0.81 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.2482 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 0.201 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.0028 | VLEACH concentration at bottom of polygon ***CLIQ*** ($g/ft^2$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 0.099 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-17. Maximum Allowable Leachate Concentration and Soil Cleanup Level for TCE - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.005 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 0.29 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.2482 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 0.072 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.213 | VLEACH concentration at bottom of polygon **CLIQ** ($g/ft^3$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 7.521 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-18. Maximum Allowable Leachate Concentration and Soil Cleanup Level for Benzo(a)Anthracene - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 9E-05 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 44 | ml/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.0046 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 0.2009 | mg/kg |

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.000168 | VLEACH concentration at bottom of polygon ***CLIQ*** ($g/ft^3$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vaz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 0.006 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination

## Table C-19. Maximum Allowable Leachate Concentration and Soil Cleanup Level for Benzo(a)Pyrene - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.0002 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 1000 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.0099 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 9.9267 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.000006 | VLEACH concentration at bottom of polygon **CLIQ** ($g/ft^3$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 0.0002 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-20. Maximum Allowable Leachate Concentration and Soil Cleanup Level for Bis(2-EthylHexyl)Phthalate - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.004 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 5000 | ml/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.1985 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 992.67 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.000007 | VLEACH concentration at bottom of polygon **CLIQ** ($g/ft^3$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 0.00025 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-21. Maximum Allowable Leachate Concentration and Soil Cleanup Level for Chrysene - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.0006 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]. | 200 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.0278 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 5.5589 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area (ft²) |
| 0.00007 | VLEACH concentration at bottom of polygon ***CLIQ*** (g/ft³) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** (ft³/d) |
| 0.0025 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-22. Maximum Allowable Leachate Concentration and Soil Cleanup Level for sec-Butylbenzene - Site 1111

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.24 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 2.83 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 11.912 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 33.711 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.054 | VLEACH concentration at bottom of polygon ***CLIQ*** ($g/ft^3$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.93 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 1.907 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-23. Maximum Allowable Leachate Concentration and Soil Cleanup Level for DDD/DDE/DDT - Site 1A-1

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 0.0003 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 178 | ml/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.0139 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 2.4737 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.00357 | VLEACH concentration at bottom of polygon ***CLIQ*** ($g/ft^3$) |
| 0.149 | Void Fraction **E** |
| 0.0276 | Seepage Velocity **Vsz** (ft/day) |
| 4.928 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 0.126 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-24. Maximum Allowable Leachate Concentration and Soil Cleanup Level for Hexachlorobenzene - Site 1A-1

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 4E-05 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 55 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.0021 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 0.1147 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.149 | VLEACH volumetric water content (dimensionless) |
| 1200 | VLEACH polygon area ($ft^2$) |
| 0.00007 | VLEACH concentration at bottom of polygon **CLIQ** ($g/ft^3$) |
| 0.149 | Void Fraction **E** |
| 0.027562256 | Seepage Velocity **Vsz** (ft/day) |
| 4.928131417 | Volumetric Flow Rate **Qp** ($ft^3/d$) |
| 0.0025 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

## Table C-25. Maximum Allowable Leachate Concentration and Soil Cleanup Level for Heptachlor Epoxide - Site 1A-1

### SUMMERS GW MIXING MODEL

$$C_{max} = C_{gw}\,((Q_p + Q_a) - Q_a C_a)/Q_p \qquad (1)(2)$$

$$C_s = K_d\, C_{max} \qquad (2)$$

| | | |
|---|---|---|
| Vsz -- Seepage velocity in downward direction [L/T]: | 0.0276 | ft/d |
| E -- Void fraction (water volume/volume of solid) in soil: | 0.149 | |
| Vdz -- Downward specific discharge (Darcy velocity) = | 0.004 | ft/d |
| Ap -- Horizontal area of pond or spill [L^2]: | 1200 | ft^2 |
| Qp -- Volumetric flow rate of liquid transporting pollutant into aquifer = " | 4.9349 | ft^3/d |
| Vsa -- Seepage velocity in aquifer [L/T]: | 0.32 | ft/d |
| Ea -- Porosity of aquifer [fraction]: | 0.3 | |
| Vda -- Specific discharge (Darcy velocity) in aquifer = | 0.096 | ft/d |
| Ha -- Thickness of aquifer [L]: | 25 | ft |
| Wp -- Surface pond for spill width perpendicular to flow direction in aquifer [L]: | 100 | ft |
| Qa -- Volumetric flow rate of ground water = | 240 | ft^3/d |
| Ca -- Initial or background concentration of pollutant in aquifer [mg/l]: | 0 | mg/l |
| Cgw -- Maximum allowable concentration in ground water (i.e., water quality goal) [mg/l]: | 3E-05 | mg/l |
| Kd -- Equilibrium partition coefficent [ml/g]: | 80 | mgl/g |
| Cmax -- Maximum allowable concentration in the infiltration (leachate) = | 0.0017 | mg/l |
| Cs -- Soil cleanup level (soil concentration) = | 0.135 | mg/kg |

(1) Summers, K., S. Gherini, and C. Chen. 1980. Methodology to Evaluate the Potential for Ground Water Contamination from Geothermal Fluid Releases. EPA-600/7-80-117, U.S. EPA/IERL, Cincinatti, Ohio

(2) U.S. EPA. 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples. EPA/540/2-89/o57, U.S, EPA/OERR, Washington, D.C.

**VLEACH WORKSHEET**

| | |
|---|---|
| 1.5 | VLEACH infiltration rate (ft/year) |
| 0.234 | VLEACH volumetric water content (dimensionless) |
| 80000 | VLEACH polygon area (ft²) |
| 0.00003 | VLEACH concentration at bottom of polygon ***CLIQ*** (g/ft³) |
| 0.234 | Void Fraction **E** |
| 0.017550326 | Seepage Velocity **Vsz** (ft/day) |
| 328.5420945 | Volumetric Flow Rate **Qp** (ft³/d) |
| 0.0011 | Leachate Concentration **Cp** (mg/L) |

**Source of Input Parameters**

- VLEACH soil properties, physical domain, and contaminant concentrations input parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)
- Contaminant physical/chemical input parameters derived from average typical values published in the technical literature.

# Table C-26. Site 1111 Contaminant Kd Calculations

| Compound | Groundwater Quality Goal (GWQG) | GWQG Source | Koc | foc | Kd (Koc x Foc) | Adjusted Kd[1] |
|---|---|---|---|---|---|---|
| 1,2,4-Trimethylbenzene | 12 ug/L | Tap Water PRG | 965 L/Kg | 0.001 - | 0.97 L/Kg | 0.97 L/Kg |
| 1,3,5-Trimethylbenzene | 12 ug/L | Tap Water PRG | 708 L/Kg | 0.001 - | 0.71 L/Kg | 0.71 L/Kg |
| Chloroform[2] | 80 ug/L | Fed MCL | 44 L/Kg | 0.001 - | 0.04 L/Kg | 0.17 L/Kg |
| cis-1,2-DCE | 6 ug/L | CA MCL | 34 L/Kg | 0.001 - | 0.03 L/Kg | 0.17 L/Kg |
| Methylene Chloride | 5 ug/L | CA MCL | 12 L/Kg | 0.001 - | 0.01 L/Kg | 0.13 L/Kg |
| Naphthalene | 6.2 ug/L | Tap Water PRG | 1288 L/Kg | 0.001 - | 1.29 L/Kg | 1.30 L/Kg |
| n-propylbenzene | 240 ug/L | Tap Water PRG | 3000 L/Kg | 0.001 - | 3.00 L/Kg | 3.00 L/Kg |
| PCE | 5 ug/L | CA MCL | 660 L/Kg | 0.001 - | 0.66 L/Kg | 0.81 L/Kg |
| TCE | 5 ug/L | CA MCL | 126 L/Kg | 0.001 - | 0.13 L/Kg | 0.29 L/Kg |
| Benzo(a)Anthracene | 0.092 ug/L | Tap Water PRG | 40100 L/Kg | 0.001 - | 40.10 L/Kg | 44.00 L/Kg |
| Benzo(a)Pyrene | 0.2 ug/L | CA MCL | 1000000 L/Kg | 0.001 - | 1000.00 L/Kg | 1000.00 L/Kg |
| Bis(2-Ethylhexyl)Phthalate | 4 ug/L | CA MCL | 5000000 L/Kg | 0.001 - | 5000.00 L/Kg | 5000.00 L/Kg |
| Chrysene | 0.56 ug/L | CMTap Water PRG | 200000 L/Kg | 0.001 - | 200.00 L/Kg | 200.00 L/Kg |
| sec-Butylbenzene | 240 ug/L | Tap Water PRG | 2830 L/Kg | 0.001 - | 2.83 L/Kg | 2.83 L/Kg |
| DDD/DDE/DDT | 0.28 ug/L | Tap Water PRG | 178000 L/Kg | 0.001 - | 178.00 L/Kg | 178.00 L/Kg |
| Hexachlorobenzene | 0.04 ug/L | Tap Water PRG | 55300 L/Kg | 0.001 - | 55.30 L/Kg | 55.00 L/Kg |
| Heptachlor Epoxide | 0.01 ug/L | CA MCL | 80000 L/Kg | 0.001 - | 80.00 L/Kg | 80.00 L/Kg |

[1] Calculated Kd adjusted from calibration with VLEACH

[2] Total trihalomethanes

## Table C-27. Site 1111 Average Soil Remedial Goals for Groundwater Protection

| Compound | Groundwater Quality Goal (GWQG) | GWQG Source | Maximum Allowed Leachate Concentration[1] | Maximum Leachate Concentration[2] from Actual Conditions | Meets GWQG | Maximum Detected Soil Concentration | Average Soil Removal RG to Meet GWQG | % Reduction in Maximum Soil Concentration |
|---|---|---|---|---|---|---|---|---|
| 1,2,4-Trimethylbenzene | 12 ug/L | Tap Water PRG | 596 ug/L | **56286** ug/L | No | **220000** ug/Kg | **575** ug/Kg | 99.7% |
| 1,3,5-Trimethylbenzene | 12 ug/L | Tap Water PRG | 596 ug/L | **19670** ug/L | No | **70800** ug/Kg | **420** ug/Kg | 99.4% |
| Chloroform[3] | 80 ug/L | Fed MCL | 3971 ug/L | 730 ug/L | Yes | 400 ug/Kg | **650** ug/Kg | None |
| cis-1,2-DCE | 6 ug/L | CA MCL | 298 ug/L | **1857** ug/L | No | **840** ug/Kg | **50** ug/Kg | 94.0% |
| Methylene Chloride | 5 ug/L | CA MCL | 248 ug/L | **5546** ug/L | No | **1200** ug/Kg | **33** ug/Kg | 97.3% |
| Naphthalene | 6.2 ug/L | Tap Water PRG | 308 ug/L | **8566** ug/L | No | **40600** ug/Kg | **400** ug/Kg | 99.0% |
| n-propylbenzene | 240 ug/L | Tap Water PRG | 11912 ug/L | 2317 ug/L | Yes | 32700 ug/Kg | **35000** ug/Kg | None |
| PCE | 5 ug/L | CA MCL | 248 ug/L | 99 ug/L | Yes | **980** ug/Kg | **200** ug/Kg | 79.6% |
| TCE | 5 ug/L | CA MCL | 248 ug/L | **7518** ug/L | No | **11500** ug/Kg | **72** ug/Kg | 99.4% |
| Benzo(a)Anthracene | 0.092 ug/L | Tap Water PRG | 4.6 ug/L | **6.5** ug/L | No | **260** ug/Kg | **200** ug/Kg | 23.1% |
| Benzo(a)Pyrene | 0.2 ug/L | CA MCL | 9.9 ug/L | 0.2 ug/L | Yes | 200 ug/Kg | **9900** ug/Kg | None |
| Bis(2-Ethylhexyl)Phthalate | 4 ug/L | CA MCL | 198 ug/L | 0.24 ug/L | Yes | 1200 ug/Kg | **992000** ug/Kg | None |
| Chrysene | 0.56 ug/L | CMTap Water PRG | 27.8 ug/L | 2.5 ug/L | Yes | 500 ug/Kg | **5500** ug/Kg | None |
| sec-Butylbenzene | 240 ug/L | Tap Water PRG | 11912 ug/L | 1930 ug/L | Yes | 25000 ug/Kg | **33700** ug/Kg | None |
| DDD/DDE/DDT | 0.28 ug/L | Tap Water PRG | 13.9 ug/L | **126** ug/L | No | **89700** ug/Kg | **2450** ug/Kg | 97.3% |
| Hexachlorobenzene | 0.04 ug/L | Tap Water PRG | 2.1 ug/L | **2.5** ug/L | No | **1800** ug/Kg | **115** ug/Kg | 93.6% |
| Heptachlor Epoxide | 0.01 ug/L | CA MCL | 1.7 ug/L | 1.1 ug/L | Yes | 9 ug/Kg | **135** ug/Kg | None |

[1] Maximum allowed leachate concentration in groundwater estimated by Summers Groundwater Mixing Model (USEPA)

[2] Maximum leachate concentration at soil-bedrock interface estimated by VLEACH Vadose Zone Transport Model (USEPA)

[3] Total Trihalomethanes as chloroform

## TABLE C-28. 12 Area Site 13 Downgradient BIOCHLOR Fate and Transport Evaluation Results - TCE WQG = MCL

**Concentration at POC**: Concentration at the point of entry to the groundwater basin resulting from an initial concentration in sentry well S13-MW19 (most downgradient deep well).

| | | | |
|---|---|---|---|
| **TCE Water Quality Goal = MCL:** | 5 ug/L | **Longitudinal Dispersivity:** | 40 ft |
| **Hydraulic Conductivity*:** | 0.001 cm/sec | **Distance to GW Basin:** | 5900 ft |
| **Hydraulic Gradient:** | 0.05 ft/ft | **Plume Width:** | 100 ft |

* BIOCHLOR soil and hydraulic parameters assume predominant sand and gravel on the canyon bed to represent most mobile contaminant migration scenario.

**TCE (No degradation)**

| Conc. In Well 21W-W | Conc. At POC | Years to breakthrough |
|---|---|---|
| ug/L | ug/L | |
| 10 | 2 | 100 |
| 20 | 4 | 100 |
| 30 | 5 | 60 |
| 50 | 5 | 50 |
| 80 | 5 | 47 |
| 100 | 5 | 46 |
| 200 | 5 | 45 |
| 300 | 5 | 43 |
| 400 | 5 | 42 |
| 500 | 5 | 41 |

TABLE C-29. 12 Area Site 13 Downgradient BIOCHLOR Fate and Transport Evaluation Results - TCE WQG = Backgrorund

**Concentration at POC:** Concentration at the point of entry to the groundwater basin resulting from an initial concentration in sentry well S13-MW19 (most downgradient deep well).

| | | | |
|---|---|---|---|
| **TCE Water Quality Goal = Background:** | 0.5 ug/L | **Longitudinal Dispersivity:** | 40 ft |
| **Hydraulic Conductivity*:** | 0.001 cm/sec | **Distance to GW Basin:** | 5900 ft |
| **Hydraulic Gradient:** | 0.05 ft/ft | **Plume Width:** | 100 ft |

* BIOCHLOR soil and hydraulic parameters assume predominant sand and gravel on the canyon bed to represent most mobile contaminant migration scenario.

**TCE (No degradation)**

| Conc. In Well 21W-W | Conc. At POC | Years to breakthrough |
|---|---|---|
| ug/L | ug/L | |
| 10 | 0.5 | 46 |
| 20 | 0.5 | 43 |
| 30 | 0.5 | 42 |
| 50 | 0.5 | 41 |
| 80 | 0.5 | 40 |
| 100 | 0.5 | 39 |
| 200 | 0.5 | 38 |
| 300 | 0.5 | 37 |
| 400 | 0.5 | 37 |
| 500 | 0.5 | 36 |

# TABLE C-30. Minimum Site Data Requirements for NAS

NAS requires the following minimum information in order to make TOR estimates. The software is intentionally designed to require these data before the analysis can proceed. If the required data are not available, TOR estimates cannot be made.

**Site Data Assessment:**

- Basic site hydrogeologic data, including estimates for hydraulic conductivity, hydraulic gradient, and porosity.
- Fraction of organic carbon (minimum, maximum, and best estimate) by which retardation factor for each contaminant are calculated.
- Contaminant concentrations detected above detection limits in three or more consecutive wells along the centerline of the plume.
- Concentrations for oxygen, iron (II), and sulfate in one or more wells along the centerline of the plume are required. Concentrations for nitrate, manganese (II), sulfide, methane, and hydrogen are optional if available.

**Time of Stabilization (TOS):**

- Source width.
- Location of the downgradient point of compliance (POC).
- Maximum allowable contaminant concentration at the POC (i.e., Regulatory Target Concentration or RTC).

**Time of Remediation (TOR):**

- The dimensions of the source NAPL.
- The mass fraction of each contaminant in the NAPL.
- The background concentration of each measured electron acceptor (e.g. oxygen, nitrate, iron (III), manganese (IV), sulfate,).
- An estimate of the NAPL mass.
- Maximum allowable concentration (Source Compliance Concentration, or SCC) at the contaminant source area.

# Table C-31. VOC Mass Calculations in Vadose and Saturated Zones - Site 1111

**TCE in Vadose Zone soil**

| Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | soil vol (L) | soil mass (kg) | VOC Mass (mg) | (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|
| 11.5 | 60 | 20 | 6 | 7200 | 203,832 | 142,682 | 205,463 | 2,362,821 | 2.363 | **5.198** |

**TCE in groundwater**

| Conc (mg/L) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | fluid vol (L) | (mg) | Mass (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.035 | 100 | 50 | 25 | 125,000 | 3,538,750 | 3,538,750 | 743,138 | 26,010 | 0.026 | 0.057 |
| 0.005 | 200 | 500 | 25 | 2,500,000 | 70,775,000 | 67,236,250 | 14,119,613 | 70,598 | 0.071 | 0.155 |
| | | | | | | | | | | **0.213** |

**TCE in saturated soil**

Kd = 0.6

| GW conc (mg/L) | Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | soil mass (kg) | mass (mg) | (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.035 | 0.02205 | 50 | 100 | 20 | 100000 | 2,831,000 | 2,831,000 | 4,076,640 | 89,890 | 0.090 | **0.198** |

**Chloroform in Vadose Zone soil**

| Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | soil vol (L) | soil mass (kg) | VOC Mass (mg) | (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.4 | 60 | 20 | 6 | 7200 | 203,832 | 142,682 | 205,463 | 82,185 | 0.082 | **0.181** |

**Chloroform in groundwater**

| Conc (mg/L) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | fluid vol (L) | (mg) | Mass (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.005 | 50 | 100 | 20 | 100,000 | 2,831,000 | 2,831,000 | 594,510 | 2,973 | 0.0 | 0 |
| | | | | | | | | | | **0.007** |

**Chloroform in saturated soil**

Kd = 0.22

| GW conc (mg/L) | Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | soil mass (kg) | mass (mg) | (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.005 | 0.0011 | 50 | 100 | 20 | 100000 | 2,831,000 | 2,831,000 | 4,076,640 | 4,484 | 0.0 | **0.010** |

**PCE in Vadose Zone soil**

| Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | soil vol (L) | soil mass (kg) | VOC Mass (mg) | (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.98 | 60 | 20 | 6 | 7200 | 203,832 | 142,682 | 205,463 | 201,353 | 0.201 | **0.443** |

## Table C-31. VOC Mass Calculations in Vadose and Saturated Zones - Site 1111

**PCE in groundwater**

| Conc (mg/L) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | fluid vol (L) | (mg) | Mass (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.024 | 50 | 100 | 20 | 100,000 | 2,831,000 | 2,831,000 | 594,510 | 14,268 | 0.014 | 0.031 |
| | | | | | | | | | | **0.031** |

**PCE in saturated soil**

Kd = 3.30

| GW conc (mg/L) | Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | soil mass (kg) | mass (mg) | (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.024 | 0.0792 | 50 | 100 | 20 | 100000 | 2,831,000 | 2,831,000 | 4,076,640 | 322,870 | 0.323 | **0.710** |

**Naphthalene in Vadose Zone soil**

| Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | soil vol (L) | soil mass (kg) | (mg) | VOC Mass (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|
| 40.6 | 60 | 20 | 6 | 7200 | 203,832 | 142,682 | 205,463 | 8,341,784 | 8.342 | **18.352** |

**Naphthalene in groundwater**

| Conc (mg/L) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | fluid vol (L) | (mg) | Mass (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.004 | 50 | 100 | 20 | 100,000 | 2,831,000 | 2,831,000 | 594,510 | 2,378 | 0.002 | 0.005 |
| | | | | | | | | | | **0.005** |

**Napthalene in saturated soil**

Kd = 6.44

| GW conc (mg/L) | Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | soil mass (kg) | mass (mg) | (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.004 | 0.02576 | 50 | 100 | 20 | 100000 | 2,831,000 | 2,831,000 | 4,076,640 | 105,014 | 0.105 | **0.231** |

**1,2,4-Trimethylbenzene in Vadose Zone soil**

| Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | soil vol (L) | soil mass (kg) | (mg) | VOC Mass (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|
| 220 | 60 | 20 | 6 | 7200 | 203,832 | 142,682 | 205,463 | 45,201,784 | 45.202 | **99.444** |

**1,2,4-Trimethylbenzene in groundwater**

| Conc (mg/L) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | fluid vol (L) | (mg) | Mass (kg) | (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|

# Table C-31. VOC Mass Calculations in Vadose and Saturated Zones - Site 1111

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.001 | | 50 | 100 | 20 | 100,000 | 2,831,000 | 2,831,000 | 594,510 | 595 | 0.001 | 0.001 |
| | | | | | | | | | | | **0.001** |
| **1,2,4-Trimethylbenzene in saturated soil** | | | | Kd = | 4.83 | | | | | | |
| GW conc (mg/L) | Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | soil mass (kg) | mass (mg) | (kg) | (lbs) |
| 0.001 | 0.00022 | 50 | 100 | 20 | 100000 | 2,831,000 | 2,831,000 | 4,076,640 | 897 | 0.001 | **0.002** |
| **1,3,5-Trimethylbenzene in Vadose Zone soil** | | | | | | | | | **VOC Mass** | | |
| Soil conc (mg/kg) | | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | soil vol (L) | soil mass (kg) | (mg) | (kg) | (lbs) |
| 71 | | 60 | 20 | 6 | 7200 | 203,832 | 142,682 | 205,463 | 14,587,849 | 14.588 | **32.093** |
| **1,3,5-Trimethylbenzene in groundwater** | | | | | | | | | | Mass | |
| Conc (mg/L) | | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | fluid vol (L) | (mg) | (kg) | (lbs) |
| 0 | | 50 | 100 | 20 | 100,000 | 2,831,000 | 2,831,000 | 594,510 | - | 0.000 | 0.000 |
| | | | | | | | | | | | **0.000** |
| **1,3,5-Trimethylbenzene in saturated soil** | | | | Kd = | 4.83 | | | | | | |
| GW conc (mg/L) | Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | soil mass (kg) | mass (mg) | (kg) | (lbs) |
| 0 | 0 | 50 | 100 | 20 | 100000 | 2,831,000 | 2,831,000 | 4,076,640 | - | 0.000 | **0.000** |
| **cis-1,2-DCE in Vadose Zone soil** | | | | | | | | | **VOC Mass** | | |
| Soil conc (mg/kg) | | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | soil vol (L) | soil mass (kg) | (mg) | (kg) | (lbs) |
| 0.84 | | 60 | 20 | 6 | 7200 | 203,832 | 142,682 | 205,463 | 172,589 | 0.173 | **0.380** |
| **cis-1,2-DCE in groundwater** | | | | | | | | | | Mass | |
| Conc (mg/L) | | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | fluid vol (L) | (mg) | (kg) | (lbs) |
| 0.025 | | 50 | 100 | 20 | 100,000 | 2,831,000 | 2,831,000 | 594,510 | 14,863 | 0.015 | 0.033 |
| | | | | | | | | | | | **0.033** |
| **cis-1,2-DCE in saturated soil** | | | | Kd = | 0.25 | | | | | | |
| GW conc (mg/L) | Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | soil mass (kg) | mass (mg) | (kg) | (lbs) |

# Table C-31. VOC Mass Calculations in Vadose and Saturated Zones - Site 1111

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.025 | 0.0055 | 50 | 100 | 20 | 100000 | 2,831,000 | 2,831,000 | 4,076,640 | 22,422 | 0.022 | **0.049** |

**n-Propylbenzene in Vadose Zone soil**

| | | | | | | | | VOC Mass | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | soil vol (L) | soil mass (kg) | (mg) | (kg) | (lbs) |
| 32.7 | 60 | 20 | 6 | 7200 | 203,832 | 142,682 | 205,463 | 6,718,629 | 6.719 | **14.781** |

**n-Propylbenzene in groundwater**

| | | | | | | | | | Mass | |
|---|---|---|---|---|---|---|---|---|---|---|
| Conc (mg/L) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | fluid vol (L) | (mg) | (kg) | (lbs) |
| 0 | 50 | 100 | 20 | 100,000 | 2,831,000 | 2,831,000 | 594,510 | - | 0.000 | 0.000 |
| | | | | | | | | | | **0.000** |

**n-Propylbenzene in saturated soil** Kd = 21.20

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GW conc (mg/L) | Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | soil mass (kg) | mass (mg) | (kg) | (lbs) |
| 0 | 0 | 50 | 100 | 20 | 100000 | 2,831,000 | 2,831,000 | 4,076,640 | - | 0.000 | **0.000** |

**Methylene Chloride in Vadose Zone soil**

| | | | | | | | | VOC Mass | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | soil vol (L) | soil mass (kg) | (mg) | (kg) | (lbs) |
| 1.2 | 60 | 20 | 6 | 7200 | 203,832 | 142,682 | 205,463 | 246,555 | 0.247 | **0.542** |

**Methylene Chloride in groundwater**

| | | | | | | | | | Mass | |
|---|---|---|---|---|---|---|---|---|---|---|
| Conc (mg/L) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | fluid vol (L) | (mg) | (kg) | (lbs) |
| 0 | 50 | 100 | 20 | 100,000 | 2,831,000 | 2,831,000 | 594,510 | - | 0.000 | 0.000 |
| | | | | | | | | | | **0.000** |

**Methylene Chloride in saturated soil** Kd = 0.24

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GW conc (mg/L) | Soil conc (mg/kg) | l (ft) | w (ft) | d (ft) | vol (ft3) | vol (L) | actual vol (L) | soil mass (kg) | mass (mg) | (kg) | (lbs) |
| 0 | 0 | 50 | 100 | 20 | 100000 | 2,831,000 | 2,831,000 | 4,076,640 | - | 0.000 | **0.000** |

**Totals**

## Table C-31. VOC Mass Calculations in Vadose and Saturated Zones - Site 1111

| | VOC Mass (kg) | VOC Mass (lbs) | % Unsat Zone | % Sat Zone |
|---|---|---|---|---|
| Vadose zone soil VOC source mass | **78** | **171** | 100% | |
| Groundwater/Saturated soil VOC mass | **0.55** | **1.49** | | 100% |
| Vadoze zone soil Chlorinated Solvents Source Mass | **3** | **6** | 4% | |
| Groundwater/Saturated soil Chlorinated Solvents Mass | **0.4** | **1.3** | | 84% |
| Total VOC source mass | | **173** | 99% | 1% |

**Estimated TOR for MNA after vadose zone source removal (NAS):**

| | |
|---|---|
| MCL | **3 years** |
| Background | **5 years** |

## TABLE C-32. Site 1111 VOC Mass Estimate Summary

| Compound | Vadose Zone | GW | Saturated Sd | Total |
|---|---|---|---|---|
| 1,2,4-Trimethylbenzene | 99 lb | 0.001 lb | 0.002 lb | 99 lb |
| 1,3,5-Trimethylbenzene | 32 lb | 0.000 lb | 0.010 lb | 32 lb |
| Chloroform | 0 lb | 0.007 lb | 0.010 lb | 0 lb |
| cis-1,2-DCE | 0 lb | 0.033 lb | 0.049 lb | 0 lb |
| Methylene Chloride | 1 lb | 0.000 lb | 0.000 lb | 1 lb |
| Naphthalene | 18 lb | 0.005 lb | 0.231 lb | 19 lb |
| n-propylbenzene | 15 lb | 0.000 lb | 0.000 lb | 15 lb |
| PCE | 0 lb | 0.031 lb | 0.710 lb | 1 lb |
| TCE | 5 lb | 0.213 lb | 0.198 lb | 6 lb |
| **Total Mass** | **171 lb** | **0.29 lb** | **1.210 lb** | **173 lb** |

**Assumptions**

1. Soil and groundwater concentrations used from 1998 and 2002/3 RI Sampling.

**Porosity:** SP 0.3 Dimensionless Aquifer is fine-grained sand

**Density:** SP 1.44 g/cm^3 Average aquifer bulk density (Phase I, p3-6, Table 3-2)

***foc:*** SP 0.005 Sand/Silty Sand Evaluating Natural Attenuation of Chlorinated Solvents in GW, 1998, Table C.3.3)

**Koc:** (EPA, Technical Protocal for Evaluating Natural Attenuation of Chlorinated Solvents in GW, 1998, Table B.2.2)

| | | |
|---|---|---|
| 1,2,4-Trimethylbenzene | 965 | L/kg |
| 1,3,5-Trimethylbenzene | 965 | L/kg |
| Chloroform | 44 | L/kg |
| cis-1,2-DCE | 49 | L/kg |
| Methylene Chloride | 48 | L/kg |
| Naphthalene | 1288 | L/kg |
| n-propylbenzene | 4240 | L/kg |
| PCE | 660 | L/kg |
| TCE | 126 | L/kg |

**Kd:**
**=foc * Koc**

| | | |
|---|---|---|
| 1,2,4-Trimethylbenzene | 4.8 | L/kg |
| 1,3,5-Trimethylbenzene | 4.8 | L/kg |
| Chloroform | 0.2 | L/kg |
| cis-1,2-DCE | 0.2 | L/kg |
| Methylene Chloride | 0.2 | L/kg |
| Naphthalene | 6.4 | L/kg |
| n-propylbenzene | 21.2 | L/kg |
| PCE | 3.3 | L/kg |
| TCE | 0.6 | L/kg |

Average Site foc = 0.005

| | | | | | | |
|---|---|---|---|---|---|---|
| **Vadose Zone Source Area:** | 60 ft x 20 ft | 6 ft deep | | | | |
| **Saturated Zone Source Area:** | 200 ft x 100 ft | 25 ft deep | | | | |
| **VZ Volume:** | 0-6 FT | 7200 ft^3 | = | 203.832 m^3 | = | 203832 L |
| **SZ Volume:** | 6-30 FT | 500000 ft^3 | = | 14155 m^3 | = | 14155000 L |

## TABLE C-33. NATURAL ATTENUATION SOFTWARE (NAS) - MODELING DATA AND RESULTS SUMMARY

***Facility Name:*** MCB Camp Pendleton
***Site Name:*** Site 1111
***Chemical of Concern:*** Chlorinated Ethenes

**UNITS**
***Length:*** feet
***Time:*** days
***Mass:*** kilograms

***Hydrogeologic Data and Contaminant Transport Calculations****

| | Average |
|---|---|
| ***Hydraulic Conductivity [ft/d]*** | 17.3 |
| ***Hydraulic Gradient [ft/ft]*** | 0.002 |
| ***Total Porosity [-]*** | 0.35 |
| ***Effective Porosity [-]*** | 0.3 |
| ***Groundwater Velocity [ft/d]*** | 0.115 |
| ***Contaminated Aquifer Thickness [ft]*** | 25 |

| ***NAS Calculations*** | Value |
|---|---|
| ***Estimated Plume Length [ft]*** | 255.8 |
| ***Longitudinal Dispersivity [ft]*** | 12.69 |
| ***Dispersivity Ratio [-]*** | 20.0 |

* Soil properties and hydrogeological parameters derived from RI lithological data and site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)

***Contaminant Data (January 2002)***

| ***Well Name*** | Distance[1] [ft] | PCE [µg/L] | TCE [µg/L] | cis-DCE [µg/L] | Vinyl Chl. [µg/L] | otal Chl. Eth. [µg/L] |
|---|---|---|---|---|---|---|
| 1111MW-03 (Source area) | 0.0 | 24 | 35 | 25 | ND | 84 |
| 1111MW-04 | 150.0 | 2.8 | 1 | ND | ND | 3.8 |
| 1111MW-06 | 200.0 | 2.9 | 0.7 | ND | ND | 3.6 |

[1] Downgradient of source area

***Redox Data (January 2002)***

| ***Well Name*** | Distance[1] [ft] | Oxygen [mg/L] | Nitrate [mg/L] | Iron(II) [mg/L] | Sulfate [mg/L] | Methane [mg/L] | Redox Condition |
|---|---|---|---|---|---|---|---|
| 1111MW-03 (Source area) | 0.0 | NS | NS | NS | NS | NS | Insufficient Data |
| 1111MW-04 | 150.0 | 5.7 | 1.2 | 0.54 | 186 | BD | Oxic |
| 1111MW-06 | 200.0 | 6.1 | 1.2 | 0.4 | 208 | BD | Oxic |

[1] Downgradient of source area

## TABLE C-33. NATURAL ATTENUATION SOFTWARE (NAS) - MODELING DATA AND RESULTS SUMMARY

***Facility Name:*** MCB Camp Pendleton
***Site Name:*** Site 1111
***Chemical of Concern:*** Chlorinated Ethenes

**UNITS**
***Length:*** feet
***Time:*** days
***Mass:*** kilograms

### *Sorption Parameters*

| | | | PCE | TCE | cis-DCE | Vinyl Chl. |
|---|---|---|---|---|---|---|
| ***Fraction Org. Carbon [-]**** | | ***Koc [L/kg]*** | 364 | 126 | 24 | 57 |
| **Average** | 0.0003 | ***Retardation Factor [-]*** | 1.63 | 1.22 | 1.04 | 1.1 |

* Fraction organic carbon derived from site-specific soil samples as presented in Appendix G of the OU 5 RI Report (Parsons 2004a)

### *NAS Natural Attenuation Rates*

| | Total Chl. Eth. | PCE | TCE |
|---|---|---|---|
| ***NAC[2] (Single Zone) [1/ft]*** | 0.0169 | 0.0114 | 0.0205 |
| ***Decay Rate [1/d]*** | 0.0024 | 0.0015 | 0.0028 |
| ***NAC[2] (Zone 1) [1/ft]*** | Insuff. Data | Insuff. Data | Insuff. Data |
| ***Decay Rate [1/d]*** | Insuff. Data | Insuff. Data | Insuff. Data |
| ***NAC[2] (Zone 2) [1/ft]*** | 0.0011 | Insuff. Data | 0.0071 |
| ***Decay Rate [1/d]*** | 0.0001 | Insuff. Data | 0.0009 |

[2] Natural attenuation capacity of the aquifer

### *Time of Stabilization (TOS) and Max Source Conc. Calculations*

| | | | |
|---|---|---|---|
| ***Distance to POC [ft]*** | 1 | ***Estimated Source Width [ft]*** | 60.0 |

| | | *Source Concentration [µg/L]* | | Average |
|---|---|---|---|---|
| ***RCC[3] Total CAHs [µg/L]*** | **Well** | **Current** | **Target** | ***TOS [years]*** |
| 5 (MCL) | 1111MW-03 | 84 | 5 | 0 |
| 0.5. (Background) | 1111MW-03 | 84 | 1 | 0 |

[3] Regulatory Compliance Concentration at POC

## TABLE C-33. NATURAL ATTENUATION SOFTWARE (NAS) - MODELING DATA AND RESULTS SUMMARY

***Facility Name:*** MCB Camp Pendleton
***Site Name:*** Site 1111
***Chemical of Concern:*** Chlorinated Ethenes

**UNITS**
***Length:*** feet
***Time:*** days
***Mass:*** kilograms

***Time of Remediation (TOR) Calculations***

| | |
|---|---|
| ***NAPL Source Width [ft]*** | 20.0 |
| ***NAPL Source Length [ft]*** | 60.0 |
| ***Contaminated Aquifer Thickness [ft]*** | 25.0 |

| ***NAPL Component*** | ***% of NAPL*** |
|---|---|
| *PCE* | 0.10 |
| *TCE* | 0.10 |
| *cis-DCE* | 0.00 |

| | Oxygen [mg/L] | Nitrate [mg/L] | Mn(IV) [mg/kg] | Iron(III) [mg/kg] | Sulfate [mg/L] |
|---|---|---|---|---|---|
| ***Background EA Conc.*** | 6.0 | 1.2 | NS | 100.0 | 208.0 |

| | |
|---|---|
| ***Average NAPL Mass [kg]*** | 78 |
| ***Maximum Time of Analysis [yr]*** | 100 |

***Source Removal Plan***

| | Plan 1 | Plan 2 | Plan 3 |
|---|---|---|---|
| ***% NAPL Removed*** | 0 | 50 | 99 |
| ***SCC[4] Total CAHs [µg/L]*** | | ***TOR Calculation (Years)*** | |
| **5 (MCL)** | ***8*** | ***6*** | ***3*** |
| **0.5 (Background)** | ***10*** | ***8*** | ***5*** |

[4] Source Compliance Concentration

# APPENDIX D
# HUMAN HEALTH RISK-BASED PRELIMINARY REMEDIATION GOALS

## D1 HUMAN HEALTH RISK-BASED PRELIMINARY REMEDIATION GOALS

Human health risk-based preliminary remediation goals (RGs) were derived using industrial-level risk predictions presented in Appendix I of the OU 5 RI Report (Parsons, 2004) and site-specific 95% UCLs (Upper Confidence Limits) for predicting exposure point concentrations (EPCs). Preliminary RGs were calculated using both California modified toxicity data and USEPA recommended toxicity data. The hierarchy of sources for the toxicity data used for each of these scenarios, risk and hazard calculation methodology, and exposure parameters and assumptions are described in detail in Appendix I of the OU 5 RI Report (Parsons, 2004a) and are not repeated herein.

Preliminary RGs were only calculated for 1) receptors whose cumulative risk or hazard predictions were above target cancer risk (1x $10^{-6}$) or noncancer hazard (1) levels for the reasonable maximum exposure (RME) scenario, and 2) site-related analytes that were determined to be chemicals of concern (COCs) (i.e., those analytes with predicted risks above 1x $10^{-6}$ and contributing significantly to predicted receptor cumulative risks) (arsenic and 2,3,7,8-tetrachlorodibenzo-p-dioxin TEQ). Preliminary RGs were also calculated for the central tendency (CT) exposure scenario in order to compare with RME results and site concentrations. Because none of the noncancer hazard predictions for any receptor at Sites 1A-1 or 1111 were above the target level of one, human health risk-based preliminary RGs were calculated using a ratio approach using only predicted and target cancer risks, where:

$$PRG_{Pathway} = \frac{(Risk_{Target})(EPC)}{Risk_{Predicted}}$$

Where:

| | | |
|---|---|---|
| $PRG_{Pathway}$ | = | Preliminary remediation goal (mg/kg) for each receptor with unacceptable risks and each exposure pathway; |
| $Risk_{Target}$ | = | Target risk level (1x $10^{-6}$); |
| $EPC$ | = | Exposure point concentration (mg/kg); |
| $Risk_{Predicted}$ | = | Predicted risk level for individual receptors. |

Individual exposure pathway preliminary RGs were then combined for each receptor using the following equation:

$$PRG_{Receptor} = \frac{1}{\frac{1}{PRG_{ingestion}} + \frac{1}{PRG_{dermal}} + \frac{1}{PRG_{inhalation}}}$$

Attachment D1 contains calculation sheets depicting the derivation of pathway- and receptor-specific preliminary RGs. For clarity and in order to facilitate the potential need to duplicate calculations, the chemical-specific parameters and toxicity data used in the OU 5 RI Report (Parsons, 2004; Tables I-7 thru I-9 [Site 1A-1] and I-38 thru I-40 [Site 1111]) are included in Attachment D2. The preliminary RG with the lowest concentration was selected from among the combined receptor preliminary RGs as the final preliminary RG for each COC (Table D-1). Because the preliminary RGs are dependant on the ratio of predicted risks and EPCs, and not on the individual values themselves,

preliminary RGs for each site are identical, therefore, only one preliminary RG is presented for both Sites 1111 and 1A-1.

The preliminary human health-based RG for arsenic of 1.8 mg/kg (Table D-1) was based on a predicted risk level calculated using an oral slope factor of 1.5 $(mg/kg\text{-}day)^{-1}$. While CalEPA's Office of Environmental Health and Hazard Assessment (OEHHA) has since published a more conservative slope factor for arsenic (9.45 $[mg/kg\text{-}day]^{-1}$), which would result in a preliminary human health-based RG of 0.34 mg/kg (1.8*1.5/9.45), this value would not change the final remediation goal since regional background concentrations are well above the risk-based concentration and actual site remediation would use the background concentration of 4.6 mg/kg listed in Table D-1 in lieu of the human health - based preliminary RG of either 1.8 or 0.34 mg/kg.

The soils to be removed at Site 1111, approximately 1100 $yd^3$ as described in Section 4.6.2.3, are herein referred to as hot-spot soils. "Virtual" EPCs for HHRA- and ERA-based COCs were calculated for this site assuming the hot-spot soil has been removed. These EPCs are below the final remediation goals presented in Table D-1. Therefore, providing confirmation samples are at or below USEPA Region 9 (2002) Industrial soil preliminary RGs, soils at Site 1111 are considered to be remediated and no further action is required for this site.

## D2 PRELIMINARY REMEDIATION GOALS FOR UNRESTRICTED LAND USE

Preliminary remediation goals (RGs) were also calculated for an unrestricted land use (Table D-2). An unrestricted land use would be achieved by meeting the standards of a residential exposure scenario. Note that a residential use of the site is not reasonably expected in the future, and therefore unrestricted land use is not a mandatory goal of cleanup for this site. However, the RGs that would achieve a residential exposure scenario are provided in this document because it is likely that they would be met if waste soils are removed as outlined in the remedial alternatives. The RGs for unrestricted land use are incorporated into this appendix for reference. If waste soils are ultimately removed, actual confirmation sample results can be compared to these RGs to determine if site cleanup meets the unrestricted land use standard.

### D2.1 Residential Soil Preliminary Remediation Goals

Residential soil preliminary RGs were calculated based on the methods and default input assumptions used by USEPA Region 9 (2004e). Two sets of residential preliminary RGs are presented: 1) one based on toxicity criteria developed by the State of California; and 2) one based on USEPA-recommended toxicity data. Any differences in the equations and input assumptions used to calculate site-specific preliminary RGs compared with those used by USEPA Region 9 (2004e) are described below.

Exposure via incidental ingestion, dermal contact, and inhalation of particulates and volatiles was incorporated quantitatively into USEPA Region 9 (2004e) residential soil preliminary RGs. Inhalation toxicity values published by Cal/EPA's (2004a) Office of Environmental Health Hazard Assessment (OEHHA) and in USEPA's (2004a) Integrated Risk Information System (IRIS) are presented as air reference concentrations (RfCs) for noncarcinogenic effects and air unit risk factors (URFs) for carcinogenic effects. USEPA Region 9 (2004e) converted RfC and URF values to inhalation reference dose (RfDi) and inhalation slope factor (SFi) values. Although earlier guidance from USEPA (1989) recommended using RfDi and SFi values, more recent guidance (USEPA, 1994, 1996a, 2001, 2002, and 2003a) does not recommend estimating intakes (i.e., mg/kg-day) for the inhalation pathway. As stated in USEPA'e Soil Screening Guidance (1996a), "EPA's [Office of Research and Development] ORD now believes that, due to portal-of-entry effects and differences in absorption in the gut versus the lungs, the conversion from concentration in air to internal dose is not always appropriate...." USEPA (1994, 1996a, 2001, 2002, and 2003a) currently recommends assessing risks and/or calculating preliminary RGs using RfCs and URFs, adjusted for exposure frequencies and durations.

Therefore, the inhalation component of USEPA Region 9 (2004e; Section 4.9) residential preliminary RG equations has been modified and site-specific carcinogenic- and noncarcinogenic-based residential preliminary RGs were calculated using the following equations for combined exposures:

**COMBINED CARCINOGENIC PRG EQUATION**

$$PRG_c = \frac{TR \times AT_c}{EF_r\left[\left(\frac{IFS_{adj} \times CSFo}{10^6 mg/kg}\right) + \left(\frac{SFS_{adj} \times ABS \times CSFo}{10^6 mg/kg}\right) + \left(\frac{ED_r \times URF}{VFs}\right)\right]}$$

Where:

| | | |
|---|---|---|
| $PRG_c$ | = | Preliminary RG based on carcinogenic effects (mg/kg) |
| $TR$ | = | Target cancer risk (unitless) |
| $AT_c$ | = | Averaging time for carcinogens (days) |
| $EF_r$ | = | Exposure frequency for residents (days/year) |
| $IFS_{adj}$ | = | Ingestion factor, soils ([mg-year]/[kg-day]) |
| $CSF_o$ | = | Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$ |
| $SFS_{adj}$ | = | Dermal factor, soils ([mg-year]/[kg-day]) |
| $ABS$ | = | Skin absorption value (unitless) |
| $ED_r$ | = | Exposure duration for residents (years) |
| $URF$ | = | Unit risk factor ($m^3/mg$) |
| $VF_s$ | = | Volatilization factor for soil ($m^3/kg$) |

**COMBINED NONCARCINOGENIC PRG EQUATION**

$$PRG_{nc} = \frac{THQ \times AT_n}{EF_r \times ED_c \left[ \left( \frac{1}{RfDo} \times \frac{IRS_c}{10^6 mg/kg} \times \frac{1}{BW_c} \right) + \left( \frac{1}{RfDo} \times \frac{SA_c \times AF \times ABS}{10^6 mg/kg} \times \frac{1}{BW_c} \right) + \left( \frac{1}{RfC} \times \frac{1}{VFs} \right) \right]}$$

Where:

| | | |
|---|---|---|
| $PRG_{nc}$ | = | Preliminary RG based on noncarcinogenic effects (mg/kg) |
| $THQ$ | = | Target hazard quotient (unitless) |
| $AT_n$ | = | Averaging time for noncarcinogens (days) |
| $EFr$ | = | Exposure frequency for residents (days/year) |
| $ED_c$ | = | Exposure duration for a child (years) |
| $RfD_o$ | = | Oral reference dose (mg/kg-day) |
| $IRS_c$ | = | Soil ingestion rate for a child (mg/day) |
| $BW_c$ | = | Body weight for a child (kg) |
| $ABS$ | = | Skin absorption value (unitless) |
| $SA_c$ | = | Exposed body surface area for a child (cm2/day) |
| $AF$ | = | Soil-to-skin adherence factor (mg/cm2) |
| $VF_s$ | = | Volatilization factor for soil (m3/kg) |
| $RfC$ | = | Reference concentration (mg/m3) |

## D2.2 Input Assumptions

Unless noted in the following paragraphs, default residential input assumptions listed in Exhibit 4-1 of USEPA Region 9 (2004e) were used when calculating residential soil preliminary RGs. Input assumptions for residential preliminary RGs will also differ slightly from values used by USEPA Region 9 (2004e) for the following parameters: 1) toxicity values; 2) site-specific soil and chemical properties; and 3) dermal absorption factors (ABS).

### D2.2.1 Toxicity Values

The same hierarchy of sources for toxicity values used in the risk assessment (both California-modified and USEPA toxicity value-based) was applied to calculate site-

specific residential soil preliminary RGs, and the values were based on the most current recommendations.

### D2.2.2 Site-Specific Soil and Chemical Properties

Chemical-specific physical properties (e.g., Henry's Law constant [H], soil organic carbon-water partition coefficient [$K_{oc}$], diffusivity in air [$D_{air}$], and diffusivity in water [$D_{wat}$]) are used in the calculation of volatilization and particulate emission factors for soil preliminary RGs. The sources of chemical-specific physical properties utilized by USEPA Region 9 (2004e) are listed in Section 4.4 of their technical support document, and included the *Soil Screening Guidance* (USEPA, 1996a), *Superfund Chemical Data Matrix* (USEPA, 1996b), *Handbook of Environmental Fate and Exposure Data for Organic Chemicals* (Howard, 1990), *Subsurface Contamination Reference Guide* (USEPA, 1990), and *Superfund Exposure Assessment Manual* (USEPA, 1988). However, some of the sources cited by USEPA Region 9 (2004e) for chemical-specific properties are not readily available, are not being kept current, or have been replaced with updated sources. The hierarchy of sources for chemical-specific properties that were used to calculate site-specific residential preliminary RGs is as follows:

1. USEPA (2001) *Soil Screening Guidance; Supplemental Guidance*, which is a supplement to USEPA *Soil Screening Guidance* (1996a);
2. USEPA (2003b) *Estimation Program Interface (EPI) Suite™ Version 3.11* for "H" and "$K_{oc}$." The EPI Suite™ is a Windows-based suite of physical/chemical property and environmental fate estimation models developed by USEPA's Office of Pollution Prevention Toxics (OPPT) and Syracuse Research Corporation (SRC); and
3. USEPA (2004d) *Wastewater Treatment Model Water9, Version 2* for diffusivities in air and water. WATER9 is a Windows-based computer program with a database listing chemical-specific parameters for many organic compounds.

The above USEPA sources (2003b and 2004d) of physical properties for chemicals not listed in USEPA *Soil Screening Guidance; Supplemental Guidance* (2001) are being proposed since: 1) many of the sources utilized by USEPA Region 9 (2004e) are older and/or not readily available; 2) USEPA's (2003b and 2004d) EPI Suite™ and Water9 software are the most current and readily available databases from USEPA; 3) they are simple and easy to use; 4) they can be used to identify physical properties for a relatively complete list of chemicals (e.g., the database utilized by the EPI Suite™ software contains over 25,000 chemicals); and 5) if a parameter is not available for a particular chemical, then these programs can estimate them based on bond contributions and group estimates.

Site-specific soil parameters (i.e., site-specific $\Theta_a$ [soil air-filled porosity] of 0.13; $\Theta_w$ (soil water-filled porosity) of 0.3; and foc [fraction organic carbon content] of 0.002) were also used to estimate diffusivities and the volatilization/particulate emission factors for the inhalation component of the preliminary RG equation.

### D2.2.3 Dermal Absorption Factors

Chemical-specific ABS values recommended in USEPA's (2004c) Final RAGS Part E (Dermal) Guidance were used to calculate soil preliminary RGs. Although "default" ABS values for metals and volatile organic compounds (VOCs) without chemical-specific values are recommended in the PEA Manual (Cal/EPA, 1994), "defaults" for these two

classes of chemicals were not used by USEPA Region 9 (2004e), are not recommended by USEPA (2004c), and were not used to calculate soil preliminary RGs since: 1) dermal absorption of volatiles is assumed to be insignificant; 2) the speciation of metals is critical to dermal absorption; and 3) there are too little data to extrapolate a defensible default value for metals (USEPA, 2004c).

A default ABS value of 0.1 for semi-volatile organic compounds (SVOCs) without chemical-specific data was used, which is consistent with DTSC (Cal/EPA, 1994), USEPA Region 9 (2004e), and USEPA (2004c) recommendations, as SVOC empirical dermal absorption fraction data are considered representative of this chemical class.

## D3 REFERENCES

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USEPA. 2004a. *Integrated Risk Information System (IRIS)*. Office of Emergency and Remedial Response. On-line Database. www.epa.gov/iris/.

USEPA. 2004c. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final.* Office of Solid Waste and Emergency Response. EPA/540/R/99/005. July.

USEPA. 2004d. *Wastewater Treatment Model Water9, Version 2* Office of Air Quality Planning and Standards. Research Triangle Park, NC. July. www.epa.gov/ttn/chief/software/water/.

USEPA Region 9. 2004e. *Region 9 Preliminary Remediation Goals (PRGs).* www.epa.gov/region09/waste/sfund/prg/index.htm.

TABLE D-1
SITES 1A1 and 1111
SUMMARY OF SOIL PRELIMINARY REMEDIATION GOALS FOR INDUSTRIAL LAND USE
OU 5 RI, MCB CAMP PENDLETON, CA

| Analyte | HRA Preliminary Remediation Goals (mg/kg) | | Background Concentration (mg/kg)[a] |
|---|---|---|---|
| | California Modified Toxicity Data | USEPA Toxicity Data | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | 0.000020 | 0.000017 | -- |
| ARSENIC | 1.8 | 1.8 | 4.6 |

a - Background concentration takem from the Santa Margarita Basin 0-15 ft bgs value in (SWDIV, 1997)

TABLE D-2
SITES 1A1 and 1111
SUMMARY OF SOIL PRELIMINARY REMEDIATION GOALS FOR UNRESTRICTED LAND USE
(BASED ON CALIFORNIA MODIFIED TOXICITY DATA)
OU 5 RI, MCB CAMP PENDLETON, CA

| Analyte | HRA Preliminary Remediation Goals (mg/kg) | | Background Concentration (mg/kg)[a] | Site |
|---|---|---|---|---|
| | CalEPA | USEPA | | |
| 1,1,1-Trichloroethane | 642.34 | 642.34 | -- | 1A1 |
| 1,2,4-Trimethylbenzene | 94.49 | 94.49 | -- | 1111 |
| 1,3,5-Trimethylbenzene (Mesitylene) | 78.95 | 78.95 | -- | 1111 |
| 2,3,7,8-Tetrachlorodibenzo-p-Dioxin | 0.0000045 | 0.0000039 | -- | 1A1, 1111 |
| 2,4 DB | NA | 548.87 | -- | 1A1 |
| Acetone | 47,548.41 | 70,392.86 | -- | 1A1, 1111 |
| alpha-Chlordane | 1.62 | 1.62 | -- | 1A1 |
| alpha-Endosulfan | 366.62 | 366.63 | -- | 1A1, 1111 |
| Aluminum | 77,039.66 | 77,039.66 | 20,999 | 1A1, 1111 |
| Antimony | 31.29 | 31.29 | 8.8 | 1A1, 1111 |
| Arsenic | 0.06 | 0.39 | 4.6 | 1A1, 1111 |
| Barium | 5,417.18 | 5,417.18 | 262 | 1A1, 1111 |
| Benzene | 0.59 | 2.01 | -- | 1A1 |
| Beryllium | 153.16 | 155.27 | 1.5 | 1A1, 1111 |
| bis(2-Ethylhexyl) Phthalate | 162.09 | 34.74 | -- | 1111 |
| Cadmium | 1.67 | 78.00 | 1.6 | 1A1, 1111 |
| Chlorobenzene | 307.54 | 307.54 | -- | 1A1 |
| Chloroform | 3.18 | 0.87 | -- | 1111 |
| Chromium, Hexavalent | 16.29 | 203.56 | -- | 1A1, 1111 |
| Chromium, Total | 1,428.52 | 1,428.52 | 33 | 1A1, 1111 |
| Chrysene | 3.78 | 62.14 | -- | 1A1, 1111 |
| cis-1,2-Dichloroethylene | 233.05 | 782.14 | -- | 1111 |
| Cobalt | 872.42 | 872.42 | 13.3 | 1A1, 1111 |
| Copper | 3,128.57 | 3,128.57 | 26.8 | 1A1, 1111 |
| Dieldrin | 0.03 | 0.30 | -- | 1A1 |
| Dinoseb | 183.31 | 183.31 | -- | 1111 |
| Endrin Aldehyde | 6.17 | 6.17 | -- | 1A1 |
| Ethylbenzene | 161.37 | 161.37 | -- | 1111 |
| Fluoranthene | 2,293.64 | 2,293.67 | -- | 1111 |
| gamma-Chlordane | 1.62 | 1.62 | -- | 1A1 |
| Hexachlorobenzene | 0.27 | 0.30 | -- | 1A1, 1111 |
| Isopropylbenzene (Cumene) | 115.02 | 115.02 | -- | 1111 |
| Lead | NA | NA | 29.1 | 1A1, 1111 |
| m,p-Xylene (Sum Of Isomers) | 197.65 | 197.65 | -- | 1111 |
| Manganese | 10,405.81 | 1,812.16 | 688 | 1A1, 1111 |
| Mercury | 23.46 | 23.46 | 0.08 | 1A1, 1111 |
| Methyl Isobutyl Ketone (4-Methyl-2-Pentanone) | 4,224.15 | 4,224.15 | -- | 1111 |
| Methylene Chloride | 15.36 | 31.21 | -- | 1111 |
| Molybdenum | 391.07 | 391.07 | 7.36 | 1A1, 1111 |
| Naphthalene | 540.27 | 262.55 | -- | 1111 |
| Nickel | 3,638.85 | 1,564.29 | 22.5 | 1A1, 1111 |
| n-Propylbenzene | 112.15 | 112.15 | -- | 1111 |
| o-Xylene (1,2-Dimethylbenzene) | 168.21 | 168.21 | -- | 1111 |
| p,p'-DDD | 2.03 | 2.03 | -- | 1A1, 1111 |
| p,p'-DDE | 1.43 | 1.43 | -- | 1A1, 1111 |
| p,p'-DDT | 1.72 | 1.72 | -- | 1A1, 1111 |
| PCB-1254 (Arochlor 1254) | 0.09 | 0.22 | -- | 1A1 |
| PCB-1260 (Arochlor 1260) | 0.09 | 0.22 | -- | 1A1 |
| p-Cymene (p-Isopropyltoluene) | NA | NA | -- | 1111 |
| Pentachlorophenol | 4.41 | 2.98 | -- | 1A1, 1111 |
| Phenanthrene | 16,916.62 | 17,202.56 | -- | 1111 |
| Pyrene | 1,720.23 | 1,720.26 | -- | 1111 |
| sec-Butylbenzene | 60.00 | 60.00 | -- | 1111 |

**TABLE D-2**
**SITES 1A1 and 1111**
**SUMMARY OF SOIL PRELIMINARY REMEDIATION GOALS FOR UNRESTRICTED LAND USE**
**(BASED ON CALIFORNIA MODIFIED TOXICITY DATA)**
**OU 5 RI, MCB CAMP PENDLETON, CA**

| Analyte | HRA Preliminary Remediation Goals (mg/kg) | | Background Concentration (mg/kg)[a] | Site |
|---|---|---|---|---|
| | CalEPA | USEPA | | |
| Selenium | 391.06 | 391.07 | 0.8 | 1A1, 1111 |
| Silver | 391.07 | 391.07 | 1.36 | 1A1, 1111 |
| tert-Butyl Methyl Ether | 110.51 | 110.51 | -- | 1111 |
| Tetrachloroethylene (PCE) | 0.81 | 0.81 | -- | 1111 |
| Thallium | 6.26 | 6.26 | 1.4 | 1111 |
| Toluene | 309.44 | 309.44 | -- | 1A1, 1111 |
| trans-1,2-Dichloroethene | 371.83 | 1,564.29 | -- | 1A1, 1111 |
| Trichloroethylene (TCE) | 7.98 | 7.98 | -- | 1A1, 1111 |
| Trichlorofluoromethane | 717.02 | 717.02 | -- | 1A1 |
| Vanadium | 78.21 | 78.21 | -- | 1A1, 1111 |
| Zinc | 23,464.29 | 23,464.29 | 111 | 1A1, 1111 |

a - Background concentration takem from the Santa Margarita Basin 0-15 ft bgs value in (SWDIV, 1997)

# ATTACHMENT D1

ATTACHMENT D1 - TABLE 1
SITE 1A-1
SUMMARY OF SOIL PRELIMINARY REMEDIATION GOALS FOR INDUSTRIAL LAND USE
(BASED ON CALIFORNIA MODIFIED TOXICITY DATA)
MCB CAMP PENDLETON, CA

| Receptor | Pathway | Exposure Point Concentration (mg/kg)[a/] | HRA Predicted Risk | HRA Preliminary Remediation Goal at 1E-6 Target Risk Level (mg/kg)[b/] |
|---|---|---|---|---|
| **Nonintrusive Worker** | | | | |
| **RME Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0027 | 1.1E-04 | 2.5E-05 |
| | Dermal Contact | | 2.2E-05 | 0.00012 |
| | Inhalation of Outdoor Air (SSL guidance) | | 3.0E-06 | 0.00090 |
| | **Combined Preliminary Remediation Goal[c/]** | | | **0.000020** |
| ARSENIC | Incidental Ingestion | 4.1 | 1.9E-06 | 2.2 |
| | Dermal Contact | | 3.8E-07 | 11 |
| | Inhalation of Outdoor Air (SSL guidance) | | 7.4E-10 | 5541 |
| | **Combined Preliminary Remediation Goal** | | | **1.8** |
| **CT Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0027 | 1.2E-06 | 0.0023 |
| | Dermal Contact | | 4.7E-08 | 0.0574 |
| | Inhalation of Outdoor Air (SSL guidance) | | 6.4E-08 | 0.0422 |
| | **Combined Preliminary Remediation Goal** | | | **0.0021** |
| ARSENIC | Incidental Ingestion | 4.1 | 2.1E-08 | 195 |
| | Dermal Contact | | 8.2E-10 | 5000 |
| | Inhalation of Outdoor Air (SSL guidance) | | 1.6E-11 | 256250 |
| | **Combined Preliminary Remediation Goal** | | | **188** |
| **Military Trainee** | | | | |
| **RME Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0027 | 3.2E-06 | 0.00084 |
| | Dermal Contact | | 2.9E-07 | 0.0093 |
| | Inhalation of Outdoor Air (SSL guidance) | | 2.7E-08 | 0.10 |
| | **Combined Preliminary Remediation Goal** | | | **0.00077** |

ATTACHMENT D1 - TABLE 1
SITE 1A-1
SUMMARY OF SOIL PRELIMINARY REMEDIATION GOALS FOR INDUSTRIAL LAND USE
(BASED ON CALIFORNIA MODIFIED TOXICITY DATA)
MCB CAMP PENDLETON, CA

| Receptor | Pathway | Exposure Point Concentration (mg/kg)[a] | HRA Predicted Risk | HRA Preliminary Remediation Goal at 1E-6 Target Risk Level (mg/kg)[b] |
|---|---|---|---|---|
| **CT Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0027 | 2.4E-07 | 0.011 |
| | Dermal Contact | | 2.3E-08 | 0.12 |
| | Inhalation of Outdoor Air (SSL guidance) | | 6.4E-08 | 0.042 |
| | **Combined Preliminary Remediation Goal** | | | **0.0083** |

[a] Exposure point concentrations were taken from Table I-14 in Parsons 2004.

[b] All COCs were driven by carcinogenic effects, therefore, no hazard-based PRGs are reported. Remediation Goals at a 1E-05 level are 1 order of magnitude greater.

[c] Combined remediation goals were calculated as $PRG = 1/[(1/PRG_{ingest})+(1/PRG_{derm})+(1/PRG_{inhal})]$, where PRG = combined remdiation goal, $PRG_{ingest}$ = remediation goal for the incidental ingestion pathway; $PRG_{derm}$ = remediation goald for the dermal exposure pathway, and $PRG_{inhal}$ = remedation goal for the inahalation pathway.

ATTACHMENT D1 - TABLE 2
SITE 1A-1
SUMMARY OF SOIL PRELIMINARY REMEDIATION GOALS FOR INDUSTRIAL LAND USE
(BASED ON USEPA TOXICITY DATA)
MCB CAMP PENDLETON, CA

| Receptor | Pathway | Exposure Point Concentration (mg/kg)[a/] | HRA Predicted Risk | HRA Preliminary Remediation Goal at 1E-6 Target Risk Level (mg/kg)[b/] |
|---|---|---|---|---|
| Nonintrusive Worker | | | | |
| **RME Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0027 | 1.3E-04 | 0.000021 |
| | Dermal Contact | | 2.5E-05 | 0.00011 |
| | Inhalation of Outdoor Air (SSL guidance) | | 3.4E-06 | 0.00079 |
| | **Combined Preliminary Remediation Goal[c/]** | | | **0.000017** |
| ARSENIC | Incidental Ingestion | 4.1 | 1.9E-06 | 2.2 |
| | Dermal Contact | | 3.8E-07 | 11 |
| | Inhalation of Outdoor Air (SSL guidance) | | 9.7E-10 | 4227 |
| | **Combined Preliminary Remediation Goal** | | | **1.8** |
| **CT Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0027 | 1.4E-06 | 0.0019 |
| | Dermal Contact | | 5.4E-08 | 0.050 |
| | Inhalation of Outdoor Air (SSL guidance) | | 7.2E-08 | 0.038 |
| | **Combined Preliminary Remediation Goal** | | | **0.0018** |
| ARSENIC | Incidental Ingestion | 4.1 | 2.1E-08 | 195 |
| | Dermal Contact | | 8.2E-10 | 5000 |
| | Inhalation of Outdoor Air (SSL guidance) | | 2.1E-11 | 195238 |
| | **Combined Preliminary Remediation Goal** | | | **188** |

**ATTACHMENT D1 - TABLE 2**
**SITE 1A-1**
**SUMMARY OF SOIL PRELIMINARY REMEDIATION GOALS FOR INDUSTRIAL LAND USE**
**(BASED ON USEPA TOXICITY DATA)**
**MCB CAMP PENDLETON, CA**

| Receptor | Pathway | Exposure Point Concentration (mg/kg)[a/] | HRA Predicted Risk | HRA Preliminary Remediation Goal at 1E-6 Target Risk Level (mg/kg)[b/] |
|---|---|---|---|---|
| **Intrusive Worker** | | | | |
| **RME Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0027 | 1.5E-06 | 0.0018 |
| | Dermal Contact | | 1.3E-07 | 0.021 |
| | Inhalation of Outdoor Air (SSL guidance) | | 1.2E-08 | 0.225 |
| | **Combined Preliminary Remediation Goal** | | | **0.0016** |
| **CT Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0027 | 2.3E-07 | 0.012 |
| | Dermal Contact | | 2.2E-08 | 0.12 |
| | Inhalation of Outdoor Air (SSL guidance) | | 6.0E-09 | 5E-01 |
| | **Combined Preliminary Remediation Goal** | | | **0.01** |
| **Military Trainee** | | | | |
| **RME Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0027 | 3.7E-06 | 0.00073 |
| | Dermal Contact | | 3.4E-07 | 0.0079 |
| | Inhalation of Outdoor Air (SSL guidance) | | 3.0E-08 | 0.090 |
| | **Combined Preliminary Remediation Goal** | | | **0.00066** |
| **CT Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0027 | 2.7E-07 | 0.010 |
| | Dermal Contact | | 2.7E-08 | 0.10 |
| | Inhalation of Outdoor Air (SSL guidance) | | 7.2E-09 | 0.3750 |
| | **Combined Preliminary Remediation Goal** | | | **0.0089** |

[a/] Exposure point concentrations were taken from Table I-14 in Parsons 2004.
[b/] All COCs were driven by carcinogenic effects, therefore, no hazard-based PRGs are reported. Remediation Goals at a 1E-05 level are 1 order of magnitude greater.
[c/] Combined remediation goals were calculated as $PRG = 1/[(1/PRG_{ingest})+(1/PRG_{derm})+(1/PRG_{inhal})]$, where PRG = combined remdiation goal, $PRG_{ingest}$ = remediation goal for the incidental ingestion pathway; $PRG_{derm}$ = remediation goald for the dermal exposure pathway, and $PRG_{inhal}$ = remedation goal for the inahalation pathway.

ATTACHMENT D1 - TABLE 3
SITE 1111
SUMMARY OF SOIL PRELIMINARY REMEDIATION GOALS FOR INDUSTRIAL LAND USE
(BASED ON CALIFORNIA MODIFIED TOXICITY DATA)
MCB CAMP PENDLETON, CA

| Receptor | Pathway | Exposure Point Concentration (mg/kg)[a] | HRA Predicted Risk | HRA Preliminary Remediation Goal at 1E-6 Target Risk Level (mg/kg)[b] |
|---|---|---|---|---|
| **Nonintrusive Worker** | | | | |
| **RME Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.00013 | 5.3E-06 | 0.000025 |
| | Dermal Contact | | 1.1E-06 | 0.00012 |
| | Inhalation of Outdoor Air (SSL guidance) | | 1.4E-07 | 0.00093 |
| | **Combined Preliminary Remediation Goal[c]** | | | **0.000020** |
| **CT Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.00013 | 5.7E-08 | 0.0023 |
| | Dermal Contact | | 2.2E-09 | 0.059 |
| | Inhalation of Outdoor Air (SSL guidance) | | 3.1E-09 | 0.042 |
| | **Combined Preliminary Remediation Goal** | | | **0.0021** |
| **Intrusive Worker** | | | | |
| **RME Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0092 | 4.4E-06 | 0.0021 |
| | Dermal Contact | | 4.0E-07 | 0.023 |
| | Inhalation of Outdoor Air (SSL guidance) | | 1.4E-07 | 0.066 |
| | **Combined Preliminary Remediation Goal** | | | **0.0019** |
| **CT Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0092 | 6.7E-07 | 0.014 |
| | Dermal Contact | | 6.6E-08 | 0.14 |
| | Inhalation of Outdoor Air (SSL guidance) | | 1.8E-08 | 5.1E-01 |
| | **Combined Preliminary Remediation Goal** | | | **0.012** |

[a] Exposure point concentrations were taken from Table I-45 in Parsons 2004.

[b] All COCs were driven by carcinogenic effects, therefore, no hazard-based PRGs are reported. Remediation Goals at a 1E-05 level are 1 order of magnitude greater.

[c] Combined remediation goals were calculated as $PRG = 1/[(1/PRG_{ingest})+(1/PRG_{derm})+(1/PRG_{inhal})]$, where PRG = combined remdiation goal, $PRG_{ingest}$ = remediation goal for the incidental ingestion pathway; $PRG_{derm}$ = remediation goald for the dermal exposure pathway, and $PRG_{inhal}$ = remedation goal for the inahalation pathway.

ATTACHMENT D1 - TABLE 4
SITE 1111
SUMMARY OF SOIL PRELIMINARY REMEDIATION GOALS FOR INDUSTRIAL LAND USE
(BASED ON USEPA TOXICITY DATA)
MCB CAMP PENDLETON, CA

| Receptor | Pathway | Exposure Point Concentration (mg/kg)[a/] | HRA Predicted Risk | HRA Preliminary Remediation Goal at 1E-6 Target Risk Level (mg/kg)[b/] |
|---|---|---|---|---|
| **Nonintrusive Worker** | | | | |
| **RME Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.00013 | 6.1E-06 | 0.000021 |
| | Dermal Contact | | 1.2E-06 | 0.00011 |
| | Inhalation of Outdoor Air (SSL guidance) | | 1.6E-07 | 0.00081 |
| | **Combined Preliminary Remediation Goal[c/]** | | | **0.000017** |
| **CT Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.00013 | 6.5E-08 | 0.0020 |
| | Dermal Contact | | 2.6E-09 | 0.050 |
| | Inhalation of Outdoor Air (SSL guidance) | | 3.5E-09 | 0.037 |
| | **Combined Preliminary Remediation Goal** | | | **0.0018** |
| **Intrusive Worker** | | | | |
| **RME Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0092 | 5.1E-06 | 0.0018 |
| | Dermal Contact | | 4.6E-07 | 0.020 |
| | Inhalation of Outdoor Air (SSL guidance) | | 4.1E-08 | 0.22 |
| | **Combined Preliminary Remediation Goal** | | | **0.0016** |
| **CT Scenario** | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN TEQ | Incidental Ingestion | 0.0092 | 7.7E-07 | 0.012 |
| | Dermal Contact | | 7.6E-08 | 0.12 |
| | Inhalation of Outdoor Air (SSL guidance) | | 2.0E-08 | 4.6E-01 |
| | **Combined Preliminary Remediation Goal** | | | **0.011** |

[a/] Exposure point concentrations were taken from Table I-45 in Parsons 2004.

[b/] All COCs were driven by carcinogenic effects, therefore, no hazard-based PRGs are reported. Remediation Goals at a 1E-05 level are 1 order of magnitude greater.

[c/] Combined remediation goals were calculated as $PRG = 1/[(1/PRG_{ingest})+(1/PRG_{derm})+(1/PRG_{inhal})]$, where PRG = combined remdiation goal, $PRG_{ingest}$ = remediation goal for the incidental ingestion pathway; $PRG_{derm}$ = remediation goald for the dermal exposure pathway, and $PRG_{inhal}$ = remedation goal for the inahalation pathway.

# ATTACHMENT D2

## TABLE I-7

## PHYSICAL PROPERTIES FOR CHEMICALS OF POTENTIAL CONCERN
## SITE 1A-1
## OU5 RI, MCB CAMP PENDLETON, CA

| | | Parameter Value[a] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COPC[b] | CAS Number[c] | H' | Ref[d] | $D^{air}(cm^2/s)$[e] | Ref | $D^{wat}(cm^2/s)$[e] | Ref | Koc (L/kg)[e] | Ref | Kd ($cm^3/g$)[e] | Ref | OAF | Ref | DAF | Ref |
| **Volatile Organic Compounds** | | | | | | | | | | | | | | | |
| 1,1,1-TRICHLOROETHANE | 71556 | 0.705 | SSL | 0.078 | SSL | 0.0000088 | SSL | 110 | SSL | 0.22 | CA | **[f] | B | --[g] | |
| ACETONE | 67641 | 0.00159 | SSL | 0.124 | SSL | 0.0000114 | SSL | 0.575 | SSL | 0.00115 | CA | ** | B | -- | |
| BENZENE | 71432 | 0.228 | SSL | 0.088 | SSL | 0.0000098 | SSL | 58.9 | SSL | 0.1178 | CA | ** | B | -- | |
| CHLOROBENZENE | 108907 | 0.152 | SSL | 0.073 | SSL | 0.0000087 | SSL | 219 | SSL | 0.438 | CA | 0.31 | B | -- | |
| TOLUENE | 108883 | 0.272 | SSL | 0.087 | SSL | 0.0000086 | SSL | 182 | SSL | 0.364 | CA | ** | B | -- | |
| TRICHLOROETHYLENE (TCE) | 79016 | 0.422 | SSL | 0.079 | SSL | 0.0000091 | SSL | 166 | SSL | 0.332 | CA | 0.15 | B | -- | |
| TRICHLOROFLUOROMETHANE | 75694 | 3.97 | EPI | 0.087 | W9 | 0.0000097 | W9 | 48.64 | EPI | 0.09728 | CA | 0.23 | B | -- | |
| trans-1,2-DICHLOROETHENE | 156605 | 0.385 | SSL | 0.0707 | SSL | 0.0000119 | SSL | 52.5 | SSL | 0.105 | CA | ** | B | -- | |
| **Semivolatile Organic Compounds** | | | | | | | | | | | | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN | 1746016 | 0.00205 | EPI | 0.104 | W9 | 0.0000056 | W9 | 146300 | EPI | 292.6 | CA | ** | U | 0.03 | U |
| CHRYSENE | 218019 | 0.00388 | SSL | 0.0248 | SSL | 6.21E-06 | SSL | 398000 | SSL | 796 | CA | ** | U | 0.13 | U |
| PCB-1254 (AROCHLOR 1254) | 11097691 | 0.0116 | EPI | 0.0202 | W9 | 0.000005 | W9 | 75600 | EPI | 151.2 | CA | ** | U | 0.14 | U |
| PCB-1260 (AROCHLOR 1260) | 11096825 | 0.0137 | EPI | 0.0228 | W9 | 5.83E-06 | W9 | 206800 | EPI | 413.6 | CA | ** | U | 0.14 | U |
| **Pesticides/Herbicides** | | | | | | | | | | | | | | | |
| 2,4 DB[h] | 94826 | 2.4E-07 | EPI | 0.0222 | W9 | 5.53E-06 | W9 | 100 | EPI | 0.2 | CA | ** | U | 0.05 | U |
| ALPHA ENDOSULFAN | 115297 | 0.000459 | SSL | 0.0115 | SSL | 4.55E-06 | SSL | 2140 | SSL | 4.28 | CA | ** | U | 0.1 | U |
| ALPHA-CHLORDANE | 12789036 | 0.00287 | EPI | 0.0169 | W9 | 4.09E-06 | W9 | 86650 | EPI | 173.3 | CA | ** | U | 0.04 | U |
| DIELDRIN | 60571 | 0.000619 | SSL | 0.0125 | SSL | 4.74E-06 | SSL | 21400 | SSL | 42.8 | CA | 0.5 | B | 0.1 | U |
| ENDRIN ALDEHYDE | 742934 | 0.0003 | SSL | 0.0125 | SSL | 4.74E-06 | SSL | 12300 | SSL | 24.6 | CA | 0.02 | B | [illegible] | U |
| GAMMA-CHLORDANE | 12789036 | 0.00287 | EPI | 0.0169 | W9 | 4.09E-06 | W9 | 86650 | EPI | 173.3 | CA | ** | U | 0.04 | U |
| HEXACHLOROBENZENE | 118741 | 0.0541 | SSL | 0.0542 | SSL | 5.91E-06 | SSL | 55000 | SSL | 110 | CA | ** | U | 0.1 | U |
| PENTACHLOROPHENOL | 87865 | 0.000001 | SSL | 0.056 | SSL | 0.0000061 | SSL | 592 | SSL | 1.184 | CA | ** | U | 0.25 | U |
| p,p'-DDD | 72548 | 0.000164 | SSL | 0.0169 | SSL | 4.76E-06 | SSL | 1000000 | SSL | 2000 | CA | ** | B | 0.1 | U |
| p,p'-DDE | 72559 | 0.000861 | SSL | 0.0144 | SSL | 5.87E-06 | SSL | 4470000 | SSL | 8940 | CA | ** | B | 0.1 | U |
| p,p'-DDT | 50293 | 0.000332 | SSL | 0.0137 | SSL | 4.95E-06 | SSL | 2630000 | SSL | 5260 | CA | ** | U | 0.03 | U |
| **Inorganics** | | | | | | | | | | | | | | | |
| ALUMINUM | 7429905 | 0 | D | -- | NU | -- | NU | -- | NU | 1500 | BAES | 0.1 | B | -- | |
| ANTIMONY | 7440360 | 0 | D | -- | NU | -- | NU | -- | NU | 45 | SSL | 0.15 | U | -- | |
| ARSENIC | 7440382 | 0 | D | -- | NU | -- | NU | -- | NU | 31 | SSL | ** | U | 0.03 | U |
| BARIUM | 7440393 | 0 | D | -- | NU | -- | NU | -- | NU | 52 | SSL | 0.07 | U | -- | |
| BERYLLIUM | 7440417 | 0 | D | -- | NU | -- | NU | -- | NU | 100000 | SSL | 0.007 | U | -- | |
| CADMIUM | 7440439 | 0 | D | -- | NU | -- | NU | -- | NU | 4300 | SSL | 0.025 | U | 0.001 | U |
| CHROMIUM, HEXAVALENT | 18540299 | 0 | D | -- | NU | -- | NU | -- | NU | 14 | SSL | 0.025 | U | -- | |
| CHROMIUM, TOTAL[i] | 7440473 | 0 | D | -- | NU | -- | NU | -- | NU | 14 | SSL | 0.013 | U | -- | |
| COBALT | 7440484 | 0 | D | -- | NU | -- | NU | -- | NU | 45 | BAES | ** | B | -- | |
| COPPER | 7440508 | 0 | D | -- | NU | -- | NU | -- | NU | 35 | BAES | 0.3 | B | -- | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LEAD | 7439921 | 0 | D | – | NU | – | NU | – | NU | 900 | BAES | 0.15 | B | – |
| MANGANESE | 7439965 | 0 | D | – | NU | – | NU | – | NU | 65 | BAES | 0.04 | U | – |
| MERCURY | 7439976 | 0 | D | – | NU | – | NU | – | NU | 200 | SSL | 0.07 | U | – |
| MOLYBDENUM | 7439987 | 0 | D | – | NU | – | NU | – | NU | 20 | BAES | 0.38 | B | – |
| NICKEL | 7440020 | 0 | D | – | NU | – | NU | – | NU | 1900 | SSL | 0.04 | U | – |
| SELENIUM | 7782492 | 0 | D | – | NU | – | NU | – | NU | 2.2 | SSL | ** | U | – |
| SILVER | 7440224 | 0 | D | – | NU | – | NU | – | NU | 110 | SSL | 0.04 | U | – |
| VANADIUM | 7440622 | 0 | D | – | NU | – | NU | – | NU | 1000 | SSL | 0.026 | U | – |
| ZINC | 7440666 | 0 | D | – | NU | – | NU | – | NU | 530 | SSL | 0.2 | B | – |

[a/] Parameters defined as: H' = Henry's law constant (unitless); $D^{air}$ = Diffusivity in air; $D^{wat}$ = Diffusivity in water; Koc = Organic carbon partition coefficient; Kd = Soil-water partition coefficient; OAF = Oral absorption factor; DAF = Dermal absorption factor.

[b/] COPC = Chemical of potential concern.

[c/] CAS = Chemical abstracts service number.

[d/] Ref = References; SSL = USEPA (2001a), U = USEPA (2001b); B = Bast & Borges (1996); W9 = USEPA (2001) Water9 software; EPI = USEPA (2000) EPISuite software; CA = Calculated per USEPA (1996a) guidance; BAES = Baes et. al. (1984); NU = Not used; D = A value of zero was used for inorganics.

[e/] Units are defined as: $cm^2/s$ = Square centimeters per second; L/kg = Liters per kilogram; and $cm^3/g$ = Cubic centimeters per gram.

[f/] "**" = Per USEPA (2001a) guidance, toxicity factors were not adjusted for chemicals with gastrointestinal absorption values greater than 50-percent.

[g/] "–" = Data unavailable.

[h/] The OAF and DAF for 2,4 D were used as surragate values for 2,4 DB.

[i/] The OAF for chromium, total was based on chromium III, which is more conservative than the OAF for chromium VI.

## TABLE I-8

## TOXICITY DATA FOR CHEMICALS OF POTENTIAL CONCERN
## SITE 1A-1 -- (BASED ON CALIFORNIA MODIFIED TOXIDITY DATA)
## OU5 RI, MCB CAMP PENDLETON, CA

| | | Parameter Value [a] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| COPC [b] | CAS Number [c] | RfDo (mg/kg-d) [d] | Ref [e] | CSFo (mg/kg-d)$^{-1}$ | Ref | RfC (µg/m$^3$) [f] | Ref | URF (µg/m$^3$)$^{-1}$ [f] | Ref | Cancer Class [g] |
| **Volatile Organic Compounds** | | | | | | | | | | |
| 1,1,1-TRICHLOROETHANE | 71556 | 0.28 | E | – [h] | | 2210 | E | – | | – |
| ACETONE | 67641 | 0.9 | I | – | | 350 | R | – | | D |
| BENZENE | 71432 | 0.004 | I | 0.1 | CAL | 60 | CAL | 0.000029 | CAL | A |
| CHLOROBENZENE | 108907 | 0.02 | I | – | | 1000 | CAL | – | | D |
| TOLUENE | 108883 | 0.2 | I | – | | 300 | CAL | – | | D |
| TRICHLOROETHYLENE (TCE) | 79016 | 0.0003 | E | 0.015 | CAL | 35 | E | 0.000002 | CAL | 2A |
| TRICHLOROFLUOROMETHANE | 75694 | 0.3 | I | – | | 700 | H | – | | NA |
| trans-1,2-DICHLOROETHENE | 156605 | 0.02 | I | – | | 70 | R | – | | – |
| **Semivolatile Organic Compounds** | | | | | | | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN | 1746016 | 1E-08 | CAL | 130000 | CAL | – | | 38 | CAL | i |
| CHRYSENE | 218019 | – | | 0.12 | CAL | – | | 0.000011 | CAL | B2 |
| PCB-1254 (AROCHLOR 1254) [i] | 11097691 | 0.00002 | I | 5 | CAL | 0.07 | R | 0.00057 | CAL | B2 |
| PCB-1260 (AROCHLOR 1260) [i] | 11096825 | – | | 5 | CAL | – | | 0.00057 | CAL | B2 |
| **Pesticides/Herbicides** | | | | | | | | | | |
| 2,4 DB | 94826 | – | | – | | – | | – | | – |
| ALPHA ENDOSULFAN | 115297 | 0.006 | I | – | | 21 | R | – | | – |
| ALPHA-CHLORDANE | 12789036 | 0.0005 | I | 0.35 | I | 0.7 | I | 0.0001 | I | B2 |
| DIELDRIN | 60571 | 0.00005 | I | 16 | CAL | 0.175 | R | 0.0046 | CAL | B2 |
| ENDRIN ALDEHYDE [j] | 742934 | 0.0003 | I | – | | 1.05 | R | – | | D |
| GAMMA-CHLORDANE | 12789036 | 0.0005 | I | 0.35 | I | 0.7 | I | 0.0001 | I | B2 |
| HEXACHLOROBENZENE | 118741 | 0.0008 | I | 1.8 | CAL | 2.8 | R | 0.00051 | CAL | B2 |
| PENTACHLOROPHENOL | 87865 | 0.03 | I | 0.081 | CAL | 105 | R | 0.0000046 | CAL | B2 |
| p,p'-DDD | 72548 | – | | 0.24 | CAL | – | | 0.000069 | CAL | B2 |
| p,p'-DDE | 72559 | – | | 0.34 | CAL | – | | 0.000097 | CAL | B2 |
| p,p'-DDT | 50293 | 0.0005 | I | 0.34 | CAL | 1.75 | R | 0.000097 | CAL | B2 |
| **Inorganics** | | | | | | | | | | |
| ALUMINUM | 7429905 | I | E | – | | 4.9 | E | – | | – |
| ANTIMONY | 7440360 | 0.0004 | I | – | | – | | – | | – |
| ARSENIC | 7440382 | 0.0003 | CAL | 1.5 | CAL | 0.03 | CAL | 0.0033 | CAL | A |
| BARIUM | 7440393 | 0.07 | I | – | | 0.49 | H | – | | D |
| BERYLLIUM | 7440417 | 0.002 | CAL | – | | 0.007 | CAL | 0.0024 | CAL | B1 |
| CADMIUM | 7440439 | 0.0005 | CAL | 0.38 | CAL | 0.02 | CAL | 0.0042 | CAL | – |
| CHROMIUM, HEXAVALENT | 18540299 | 0.02 | CAL | – | | 0.2 | CAL | 0.15 | CAL | A & D |
| CHROMIUM, TOTAL [k] | 7440473 | 0.021 | I | – | | 0.7 | I | 0.00171 | I | A |
| COBALT | 7440484 | 0.02 | E | – | | 0.0202 | E | 0.0028 | E | – |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| COPPER | 7440508 | 0.04 | H | – | | – | | – | | D |
| LEAD[l] | 7439921 | – | | – | NU | – | | – | NU | B2 |
| MANGANESE | 7439965 | 0.14 | I | – | | 0.2 | CAL | – | | D |
| MERCURY | 7439976 | 0.0003 | CAL | – | | 0.09 | CAL | – | | C |
| MOLYBDENUM | 7439987 | 0.005 | I | – | | – | | – | | – |
| NICKEL | 7440020 | 0.05 | CAL | – | | 0.05 | CAL | 0.00026 | CAL | – |
| SELENIUM | 7782492 | 0.005 | I | – | | 20 | CAL | – | | D |
| SILVER | 7440224 | 0.005 | I | – | | – | | – | | D |
| VANADIUM | 7440622 | 0.007 | H | – | | – | | – | | – |
| ZINC | 7440666 | 0.3 | I | – | | – | | – | | D |

[a] Parameters defined as: CSFo = Oral cancer slope factor; RfDo = Oral reference dose; URF = Unit risk factor; RfC = Reference concentration.

[b] COPC = Chemical of potential concern.

[c] CAS = Chemical abstracts service number.

[d] mg/Kg-d = Milligram per kilogram per day.

[e] Ref = References; I = USEPA (2003), Integrated Risk Information System (IRIS); H = USEPA (1997) Health Effects Assessment Summary Tables (HEAST); E = USEPA National Environmental Assessment per USEPA Region 9 (2002); CAL = California EPA limit.

[f] $\mu g/m^3$ = Micrograms per cubic meter.

[g] Based on USEPA cancer classifications (or International Agency for Research on Cancer [IARC] if USEPA classifications were unavailable). Refer to USEPA (2003) at www.epa.gov/iris/carcino.htm or IARC's web page (http://monographs.iarc.fr/monoeval/eval.html) for definitions of the reported cancer classifications.

[h] – = Data unavailable.

[i] SFO and URF toxicity data for polychlorinated biphenyls were used as surrogate values for arochlors.

[j] Toxicity data for endrin were used as surrogate values for endrin aldehyde.

[k] Chromium, total is assumed to consist of CrVI:CrIII at a ratio of 1:6 (USEPA Region 9, 2002) and the toxicity values have been adjusted accordingly.

[l] Toxicity criteria were not available for lead and it was evaluated separately using DTSC (2000) and/or USEPA (1994 and/or 1996) guidance.

## TABLE I-9

## TOXICITY DATA FOR CHEMICALS OF POTENTIAL CONCERN
## SITE 1A-1
## OU5 RI, MCB CAMP PENDLETON, CA

| COPC[b] | CAS Number[c] | Parameter Value[a] RfDo (mg/kg-d)[d] | Ref[e] | CSFo (mg/kg-d)[-1] | Ref | RfC (µg/m³)[f] | Ref | URF (µg/m³)[-1f] | Ref | Cancer Class[g] |
|---|---|---|---|---|---|---|---|---|---|---|
| **Volatile Organic Compounds** | | | | | | | | | | |
| 1,1,1-TRICHLOROETHANE | 71556 | 0.28 | E | --[h] | | 2210 | E | -- | | -- |
| ACETONE | 67641 | 0.9 | I | -- | | -- | | -- | | D |
| BENZENE | 71432 | 0.004 | I | 0.055 | I | 30 | I | 0.0000078 | I | A |
| CHLOROBENZENE | 108907 | 0.02 | I | -- | | 59.5 | E | -- | | D |
| TOLUENE | 108883 | 0.2 | I | -- | | 400 | I | -- | | D |
| TRICHLOROETHYLENE (TCE) | 79016 | 0.0003 | E | 0.4 | E | 35 | E | 0.000114 | E | 2A |
| TRICHLOROFLUOROMETHANE | 75694 | 0.3 | I | -- | | 700 | H | -- | | NA |
| trans-1,2-DICHLOROETHENE | 156605 | 0.02 | I | -- | | -- | | -- | | -- |
| **Semivolatile Organic Compounds** | | | | | | | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN | 1746016 | -- | | 150000 | H | -- | | 42.9 | H | I |
| CHRYSENE | 218019 | -- | | 0.0073 | E | -- | | -- | | B2 |
| PCB-1254 (AROCHLOR 1254)[i] | 11097691 | 0.00002 | I | 2 | I | -- | | 0.0001 | I | B2 |
| PCB-1260 (AROCHLOR 1260)[i] | 11096825 | -- | | 2 | I | -- | | 0.0001 | I | B2 |
| **Pesticides/Herbicides** | | | | | | | | | | |
| 2,4 DB | 94826 | 0.008 | I | -- | | -- | | -- | | -- |
| ALPHA ENDOSULFAN | 115297 | 0.006 | I | -- | | -- | | -- | | -- |
| ALPHA-CHLORDANE | 12789036 | 0.0005 | I | 0.35 | I | 0.7 | I | 0.0001 | I | B2 |
| DIELDRIN | 60571 | 0.00005 | I | 1.6 | I | -- | | 0.0046 | I | B2 |
| ENDRIN ALDEHYDE[j] | 742934 | 0.0003 | I | -- | | -- | | -- | | D |
| GAMMA-CHLORDANE | 12789036 | 0.0005 | I | 0.35 | I | 0.7 | I | 0.0001 | I | B2 |
| HEXACHLOROBENZENE | 118741 | 0.0008 | I | 1.6 | I | -- | | 0.00046 | I | B2 |
| PENTACHLOROPHENOL | 87865 | 0.03 | I | 0.12 | I | -- | | -- | | B2 |
| p,p'-DDD | 72548 | -- | | 0.24 | I | -- | | -- | | B2 |
| p,p'-DDE | 72559 | -- | | 0.34 | I | -- | | -- | | B2 |
| p,p'-DDT | 50293 | 0.0005 | I | 0.34 | I | -- | | 0.000097 | I | B2 |
| **Inorganics** | | | | | | | | | | |
| ALUMINUM | 7429905 | I | E | -- | | 4.9 | E | -- | | -- |
| ANTIMONY | 7440360 | 0.0004 | I | -- | | -- | | -- | | -- |
| ARSENIC | 7440382 | 0.0003 | I | 1.5 | I | -- | | 0.0043 | I | A |
| BARIUM | 7440393 | 0.07 | I | -- | | 0.49 | H | -- | | D |
| BERYLLIUM | 7440417 | 0.002 | I | -- | | 0.02 | I | 0.0024 | I | B1 |
| CADMIUM | 7440439 | 0.001 | I | -- | | -- | | 0.0018 | I | -- |
| CHROMIUM, HEXAVALENT | 18540299 | 0.003 | I | -- | | 0.1 | I | 0.0012 | I | A & D |
| CHROMIUM, TOTAL[k] | 7440473 | 0.021 | I | -- | | 0.7 | I | 0.00171 | I | A |
| COBALT | 7440484 | 0.02 | E | -- | | 0.0202 | E | 0.0028 | E | -- |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| COPPER | 7440508 | 0.04 | H | -- | -- | | -- | D |
| LEAD[l] | 7439921 | -- | | -- | -- | | -- | B2 |
| MANGANESE | 7439965 | 0.14 | I | -- | 0.05 | I | -- | D |
| MERCURY | 7439976 | 0.0003 | I | -- | -- | | -- | C |
| MOLYBDENUM | 7439987 | 0.005 | I | -- | -- | | -- | -- |
| NICKEL | 7440020 | 0.02 | I | -- | -- | | -- | -- |
| SELENIUM | 7782492 | 0.005 | I | -- | -- | | -- | D |
| SILVER | 7440224 | 0.005 | I | -- | -- | | -- | D |
| VANADIUM | 7440622 | 0.007 | H | -- | -- | | -- | -- |
| ZINC | 7440666 | 0.3 | I | -- | -- | | -- | D |

[a] Parameters defined as: CSFo = Oral cancer slope factor; RfDo = Oral reference dose; URF = Unit risk factor; RfC = Reference concentration.

[b] COPC = Chemical of potential concern.

[c] CAS = Chemical abstracts service number.

[d] mg/Kg-d = Milligram per kilogram per day.

[e] Ref = References; I = USEPA (2003), Integrated Risk Information System (IRIS); H = USEPA (1997) Health Effects Assessment Summary Tables (HEAST); E = USEPA National Environmental Assessment per USEPA Region 9 (2002).

[f] $\mu g/m^3$ = Micrograms per cubic meter.

[g] Based on USEPA cancer classifications (or International Agency for Research on Cancer [IARC] if USEPA classifications were unavailable). Refer to USEPA (2003) at www.epa.gov/iris/carcino.htm or IARC's web page (http://monographs.iarc.fr/monoeval/eval.html) for definitions of the reported cancer classifications.

[h] -- = Data unavailable.

[i] SFO and URF toxicity data for polychlorinated biphenyls were used as surrogate values for arochlors.

[j] Toxicity data for endrin were used as surrogate values for endrin aldehyde.

[k] Chromium, total is assumed to consist of CrVI:CrIII at a ratio of 1:6 (USEPA Region 9, 2002) and the toxicity values have been adjusted accordingly.

[l] Toxicity criteria were not available for lead and it was evaluated separately using DTSC (2000) and/or USEPA (1994 and/or 1996) guidance.

TABLE I-38

PHYSICAL PROPERTIES FOR CHEMICALS OF POTENTIAL CONCERN
SITE - 1111
OU5 RI, MCB CAMP PENDLETON, CA

| COPC[b] | CAS Number[c] | Parameter Value[a] H' | Ref[d] | $D^{air}(cm^2/s)$[e] | Ref | $D^{wat}(cm^2/s)$[e] | Ref | Koc (L/kg)[e] | Ref | Kd ($cm^3/g$)[e] | Ref | OAF | Ref | DAF | Ref |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Volatile Organic Compounds** | | | | | | | | | | | | | | | |
| 1,1,2,2-TETRACHLOROETHANE | 79345 | 0.0141 | SSL | 0.071 | SSL | 0.0000079 | SSL | 93.3 | SSL | 0.1866 | CA | **[f] | B | --[g] | |
| 1,1,2-TRICHLOROETHANE | 79005 | 0.0374 | SSL | 0.078 | SSL | 0.0000088 | SSL | 50.1 | SSL | 0.1002 | CA | ** | B | -- | |
| 1,1-DICHLOROETHENE | 75354 | 1.07 | SSL | 0.09 | SSL | 0.0000104 | SSL | 58.9 | SSL | 0.1178 | CA | ** | B | -- | |
| 1,2,4-TRIMETHYLBENZENE | 95636 | 0.252 | EPI | 0.0606 | W9 | 7.92E-06 | W9 | 717.6 | EPI | 1.435 | CA | ** | U | -- | |
| 1,2-DICHLOROETHANE | 107062 | 0.0401 | SSL | 0.104 | SSL | 0.0000099 | SSL | 17.4 | SSL | 0.0348 | CA | ** | B | -- | |
| 1,3,5-TRIMETHYLBENZENE (MESITYLENE) | 108678 | 0.359 | EPI | 0.0602 | W9 | 8.67E-06 | W9 | 703 | EPI | 1.406 | CA | ** | U | -- | |
| ACETONE | 67641 | 0.00159 | SSL | 0.124 | SSL | 0.0000114 | SSL | 0.575 | SSL | 0.00115 | CA | ** | B | -- | |
| BENZENE | 71432 | 0.228 | SSL | 0.088 | SSL | 0.0000098 | SSL | 58.9 | SSL | 0.1178 | CA | ** | B | -- | |
| CHLOROFORM | 67663 | 0.15 | SSL | 0.104 | SSL | 0.00001 | SSL | 39.8 | SSL | 0.0796 | CA | 0.2 | B | -- | |
| ETHYLBENZENE | 100414 | 0.323 | SSL | 0.075 | SSL | 0.0000078 | SSL | 363 | SSL | 0.726 | CA | ** | B | -- | |
| FLUORENE | 86737 | 0.00261 | SSL | 0.0363 | SSL | 7.88E-06 | SSL | 13800 | SSL | 27.6 | CA | ** | U | 0.13 | U |
| ISOPROPYLBENZENE (CUMENE) | 98828 | 0.47 | EPI | 0.065 | W9 | 0.0000071 | W9 | 817.2 | EPI | 1.634 | CA | ** | U | -- | |
| M,P-XYLENE (SUM OF ISOMERS) | 1330207 | 0.271 | EPI | 0.073 | W9 | 9.23E-06 | W9 | 443.1 | EPI | 0.8862 | CA | ** | U | -- | |
| METHYL ETHYL KETONE (2-BUTANONE) | 78933 | 0.00233 | EPI | 0.0808 | W9 | 0.0000098 | W9 | 3.827 | EPI | 0.007654 | CA | ** | B | -- | |
| METHYL ISOBUTYL KETONE (4-METHYL-2-PENTANONE) | 108101 | 0.00564 | EPI | 0.075 | W9 | 0.0000078 | W9 | 10.91 | EPI | 0.02182 | CA | ** | B | -- | |
| METHYLENE CHLORIDE | 75092 | 0.0898 | SSL | 0.101 | SSL | 0.0000117 | SSL | 11.7 | SSL | 0.0234 | CA | ** | B | -- | |
| NAPHTHALENE | 91203 | 0.0198 | SSL | 0.059 | SSL | 0.0000075 | SSL | 2000 | SSL | 4 | CA | ** | U | 0.13 | U |
| O-XYLENE (1,2-DIMETHYLBENZENE) | 1330207 | 0.213 | SSL | 0.087 | SSL | 0.00001 | SSL | 363 | SSL | 0.726 | CA | ** | U | -- | |
| P-CYMENE (p-ISOPROPYLTOLUENE) | 99876 | 0.451 | EPI | 0.056 | W9 | 7.33E-06 | W9 | 1324 | EPI | 2.648 | CA | ** | U | -- | |
| PHENANTHRENE | 85018 | 0.00173 | EPI | 0.0375 | W9 | 7.47E-06 | W9 | 20830 | EPI | 41.66 | CA | ** | U | 0.13 | U |
| SEC-BUTYLBENZENE | 135988 | 0.569 | EPI | 0.057 | W9 | 8.12E-06 | W9 | 1579 | EPI | 3.158 | CA | ** | U | -- | |
| TETRACHLOROETHYLENE (PCE) | 127184 | 0.754 | SSL | 0.072 | SSL | 0.0000082 | SSL | 155 | SSL | 0.31 | CA | ** | B | -- | |
| TOLUENE | 108883 | 0.272 | SSL | 0.087 | SSL | 0.0000086 | SSL | 182 | SSL | 0.364 | CA | ** | B | -- | |
| TRICHLOROETHYLENE (TCE) | 79016 | 0.422 | SSL | 0.079 | SSL | 0.0000091 | SSL | 166 | SSL | 0.332 | CA | 0.15 | B | -- | |
| cis-1,2-DICHLOROETHYLENE | 156592 | 0.167 | SSL | 0.0736 | SSL | 0.0000113 | SSL | 35.5 | SSL | 0.071 | CA | ** | U | -- | |
| n-PROPYLBENZENE | 103651 | 0.4305 | EPI | 0.0601 | W9 | 7.83E-06 | W9 | 955 | EPI | 1.91 | CA | ** | U | -- | |
| tert-BUTYL METHYL ETHER | 1634044 | 0.024 | EPI | 0.1024 | W9 | 0.0000105 | W9 | 5.26 | EPI | 0.01052 | CA | ** | U | -- | |
| trans-1,2-DICHLOROETHENE | 156605 | 0.385 | SSL | 0.0707 | SSL | 0.0000119 | SSL | 52.5 | SSL | 0.105 | CA | ** | B | -- | |
| **Semivolatile Organic Compounds** | | | | | | | | | | | | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN | 1746016 | 0.00205 | EPI | 0.104 | W9 | 0.0000056 | W9 | 146300 | EPI | 292.6 | CA | ** | U | 0.03 | U |
| CHRYSENE | 218019 | 0.00388 | SSL | 0.0248 | SSL | 6.21E-06 | SSL | 398000 | SSL | 796 | CA | ** | U | 0.13 | U |
| FLUORANTHENE | 206440 | 0.00066 | SSL | 0.0302 | SSL | 6.35E-06 | SSL | 107000 | SSL | 214 | CA | ** | U | 0.13 | U |
| PYRENE | 129000 | 0.000451 | SSL | 0.0272 | SSL | 7.24E-06 | SSL | 105000 | SSL | 210 | CA | ** | U | 0.13 | U |
| bis(2-ETHYLHEXYL) PHTHALATE | 117817 | 4.18E-06 | SSL | 0.0351 | SSL | 3.66E-06 | SSL | 1.51E+07 | SSL | 30200 | CA | 0.19 | B | 0.1 | U |
| **Pesticides/Herbicides** | | | | | | | | | | | | | | | |
| 2,4,5-T (TRICHLOROPHENOXYACETIC ACID) | 93765 | 1.91E-06 | EPI | 0.0251 | W9 | 0.0000067 | W9 | 48.6 | EPI | 0.0972 | CA | ** | U | 0.1 | U |
| 2,4,5-TRICHLOROPHENOL | 95954 | 0.000178 | SSL | 0.0291 | SSL | 7.03E-06 | SSL | 1600 | SSL | 3.2 | CA | ** | U | -- | |
| ALPHA BHC (ALPHA HEXACHLOROCYCLOHEXANE) | 319846 | 0.000435 | SSL | 0.0142 | SSL | 7.34E-06 | SSL | 1230 | SSL | 2.46 | CA | ** | B | 0.04 | U |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALPHA ENDOSULFAN | 115297 | 0.000459 | SSL | 0.0115 | SSL | 4.55E-06 | SSL | 2140 | SSL | 4.28 | CA | ** | U | 0.1 | U |
| DALAPON | 75990 | 3.69E-06 | EPI | -- | -- | -- | -- | 2.74 | EPI | 0.00548 | CA | ** | U | 0.1 | U |
| DINOSEB | 88857 | 0.0000186 | EPI | 0.0245 | W9 | 6.25E-06 | W9 | 3500 | EPI | 7.08 | CA | ** | U | 0.1 | U |
| HEPTACHLOR | 76448 | 0.0447 | SSL | 0.0112 | SSL | 5.69E-06 | SSL | 1410000 | SSL | 2820 | CA | ** | B | 0.1 | U |
| HEXACHLOROBENZENE | 118741 | 0.0541 | SSL | 0.0542 | SSL | 5.91E-06 | SSL | 55000 | SSL | 110 | CA | ** | U | 0.1 | U |
| METHOXYCHLOR | 72435 | 0.000648 | SSL | 0.0156 | SSL | 4.46E-06 | SSL | 97700 | SSL | 195.4 | CA | ** | U | 0.1 | U |
| PENTACHLOROPHENOL | 87865 | 0.000001 | SSL | 0.056 | SSL | 0.0000061 | SSL | 592 | SSL | 1.184 | CA | ** | U | 0.25 | U |
| p,p'-DDD | 72548 | 0.000164 | SSL | 0.0169 | SSL | 4.76E-06 | SSL | 1000000 | SSL | 2000 | CA | ** | B | 0.1 | U |
| p,p'-DDE | 72559 | 0.000861 | SSL | 0.0144 | SSL | 5.87E-06 | SSL | 4470000 | SSL | 8940 | CA | ** | B | 0.1 | U |
| p,p'-DDT | 50293 | 0.000332 | SSL | 0.0137 | SSL | 4.95E-06 | SSL | 2630000 | SSL | 5260 | CA | ** | U | 0.03 | U |
| **Inorganics** | | | | | | | | | | | | | | | |
| ALUMINUM | 7429905 | 0 | D | -- | NU | -- | NU | -- | NU | 1500 | BAES | 0.1 | B | -- | |
| ANTIMONY | 7440360 | 0 | D | -- | NU | -- | NU | -- | NU | 45 | SSL | 0.15 | U | -- | |
| ARSENIC | 7440382 | 0 | D | -- | NU | -- | NU | -- | NU | 31 | SSL | ** | U | 0.03 | U |
| BARIUM | 7440393 | 0 | D | -- | NU | -- | NU | -- | NU | 52 | SSL | 0.07 | U | -- | |
| BERYLLIUM | 7440417 | 0 | D | -- | NU | -- | NU | -- | NU | 100000 | SSL | 0.007 | U | -- | |
| CADMIUM | 7440439 | 0 | D | -- | NU | -- | NU | -- | NU | 4300 | SSL | 0.025 | U | 0.001 | U |
| CHROMIUM, HEXAVALENT | 18540299 | 0 | D | -- | NU | -- | NU | -- | NU | 14 | SSL | 0.025 | U | -- | |
| CHROMIUM, TOTAL [h/] | 7440473 | 0 | D | -- | NU | -- | NU | -- | NU | 14 | SSL | 0.013 | U | -- | |
| COBALT | 7440484 | 0 | D | -- | NU | -- | NU | -- | NU | 45 | BAES | ** | B | -- | |
| COPPER | 7440508 | 0 | D | -- | NU | -- | NU | -- | NU | 35 | BAES | 0.3 | B | -- | |
| LEAD | 7439921 | 0 | D | -- | NU | -- | NU | -- | NU | 900 | BAES | 0.15 | B | -- | |
| MANGANESE | 7439965 | 0 | D | -- | NU | -- | NU | -- | NU | 65 | BAES | 0.04 | U | -- | |
| MERCURY | 7439976 | 0 | D | -- | NU | -- | NU | -- | NU | 200 | SSL | 0.07 | U | -- | |
| MOLYBDENUM | 7439987 | 0 | D | -- | NU | -- | NU | -- | NU | 20 | BAES | 0.38 | B | -- | |
| NICKEL | 7440020 | 0 | D | -- | NU | -- | NU | -- | NU | 1900 | SSL | 0.04 | U | -- | |
| SELENIUM | 7782492 | 0 | D | -- | NU | -- | NU | -- | NU | 2.2 | SSL | ** | U | -- | |
| SILVER | 7440224 | 0 | D | -- | NU | -- | NU | -- | NU | 110 | SSL | 0.04 | U | -- | |
| THALLIUM | 7440280 | 0 | D | -- | NU | -- | NU | -- | NU | 96 | SSL | ** | U | -- | |
| VANADIUM | 7440622 | 0 | D | -- | NU | -- | NU | -- | NU | 1000 | SSL | 0.026 | U | -- | |
| ZINC | 7440666 | 0 | D | -- | NU | -- | NU | -- | NU | 530 | SSL | 0.2 | B | -- | |
| **Explosives** | | | | | | | | | | | | | | | |
| 2,6-DINITROTOLUENE | 606202 | 0.0000306 | SSL | 0.0327 | SSL | 7.26E-06 | SSL | 69.2 | SSL | 0.1384 | CA | ** | B | 0.1 | U |

[a/] Parameters defined as: H' = Henry's law constant (unitless); $D^{air}$ = Diffusivity in air; $D^{wat}$ = Diffusivity in water; Koc = Organic carbon partition coefficient; Kd = Soil-water partition coefficient; OAF = Oral absorption factor; DAF = Dermal absorption factor.

[b/] COPC = Chemical of potential concern.

[c/] CAS = Chemical abstracts service number.

[d/] Ref = References; SSL = USEPA (2001a), U = USEPA (2001b); B = Bast & Borges (1996); W9 = USEPA (2001) Water9 software; EPI = USEPA (2000) EPISuite software; CA = Calculated per USEPA (1996a) guidance; BAES = Baes et. al. (1984); NU = Not used; D = A value of zero was used for inorganics.

[e/] Units are defined as: $cm^2/s$ = Square centimeters per second; L/kg = Liters per kilogram; and $cm^3/g$ = Cubic centimeters per gram.

[f/] "**" = Per USEPA (2001a) guidance, toxicity factors were not adjusted for chemicals with gastrointestinal absorption values greater than 50-percent.

[g/] "--" = Data unavailable.

[h/] The OAF for chromium, total was based on chromium III, which is more conservative than the OAF for chromium VI.

TABLE I-39

TOXICITY DATA FOR CHEMICALS OF POTENTIAL CONCERN
SITE - 1111 -- (BASED ON CALIFORNIA MODIFIED TOXIDITY DATA)
OU5 RI, MCB CAMP PENDLETON, CA

| | | Parameter Value [a] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| COPC [b] | CAS Number [c] | RfDo (mg/kg-d) [d] | Ref [e] | CSFo (mg/kg-d)[-1] [i] | Ref | RfC (µg/m$^3$) [f] | Ref | URF (µg/m$^3$)$^{-1}$ [f] | Ref | Cancer Class [g] |
| **Volatile Organic Compounds** | | | | | | | | | | |
| 1,1,2,2-TETRACHLOROETHANE | 79345 | 0.06 | E | 0.27 | CAL | 210 | R | 0.000058 | CAL | C |
| 1,1,2-TRICHLOROETHANE | 79005 | 0.004 | I | 0.072 | CAL | 14 | R | 0.000016 | CAL | C |
| 1,1-DICHLOROETHENE | 75354 | 0.05 | I | -- [h] | | 70 | CAL | -- | | C |
| 1,2,4-TRIMETHYLBENZENE | 95636 | 0.05 | E | -- | | 5.95 | E | -- | | -- |
| 1,2-DICHLOROETHANE | 107062 | 0.03 | E | 0.047 | CAL | 400 | CAL | 0.000021 | CAL | B2 |
| 1,3,5-TRIMETHYLBENZENE (MESITYLENE) | 108678 | 0.05 | E | -- | | 5.95 | E | -- | | -- |
| ACETONE | 67641 | 0.9 | I | -- | | 350 | R | -- | | D |
| BENZENE | 71432 | 0.004 | I | 0.1 | CAL | 60 | CAL | 0.000029 | CAL | A |
| CHLOROFORM | 67663 | 0.01 | I | 0.031 | CAL | 300 | CAL | 0.0000053 | CAL | B2 |
| ETHYLBENZENE | 100414 | 0.1 | I | 0.00385 | R | 2000 | CAL | 0.0000011 | E | D |
| FLUORENE | 86737 | 0.04 | I | -- | | 140 | R | -- | | D |
| ISOPROPYLBENZENE (CUMENE) | 98828 | 0.1 | I | -- | | 400 | I | -- | | D |
| M,P-XYLENE (SUM OF ISOMERS) [j] | 1330207 | 0.2 | I | -- | | 700 | CAL | -- | | 3 |
| METHYL ETHYL KETONE (2-BUTANONE) | 78933 | 0.6 | I | -- | | 5000 | I | -- | | D |
| METHYL ISOBUTYL KETONE (4-METHYL-2-PENTANONE) | 108101 | 0.08 | H | -- | | 3 | I | -- | | -- |
| METHYLENE CHLORIDE | 75092 | 0.06 | I | 0.014 | CAL | 400 | CAL | 0.000001 | CAL | B2 |
| NAPHTHALENE | 91203 | 0.02 | I | -- | | 9 | CAL | -- | | C |
| O-XYLENE (1,2-DIMETHYLBENZENE) [j] | 1330207 | 0.2 | I | -- | | 700 | CAL | -- | | 3 |
| P-CYMENE (p-ISOPROPYLTOLUENE) | 99876 | -- | | -- | | -- | | -- | | -- |
| PHENANTHRENE [j] | 85018 | 0.3 | I | -- | | 1050 | R | -- | | D |
| SEC-BUTYLBENZENE | 135988 | 0.04 | E | -- | | 140 | R | -- | | D |
| TETRACHLOROETHYLENE (PCE) | 127184 | 0.01 | I | 0.54 | CAL | 35 | CAL | 0.0000059 | CAL | 2A |
| TOLUENE | 108883 | 0.2 | I | -- | | 300 | CAL | -- | | D |
| TRICHLOROETHYLENE (TCE) | 79016 | 0.0003 | E | 0.015 | CAL | 35 | E | 0.000002 | CAL | 2A |
| cis-1,2-DICHLOROETHYLENE | 156592 | 0.01 | H | -- | | 35 | R | -- | | D |
| n-PROPYLBENZENE | 103651 | 0.04 | E | -- | | 140 | R | -- | | -- |
| tert-BUTYL METHYL ETHER | 1634044 | -- | | 0.0018 | CAL | 8000 | CAL | 2.6E-07 | CAL | -- |
| trans-1,2-DICHLOROETHENE | 156605 | 0.02 | I | -- | | 70 | R | -- | | -- |
| **Semivolatile Organic Compounds** | | | | | | | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN | 1746016 | 1E-08 | CAL | 130000 | CAL | -- | | 38 | CAL | I |
| CHRYSENE | 218019 | -- | | 0.12 | CAL | -- | | 0.000011 | CAL | B2 |
| FLUORANTHENE | 206440 | 0.04 | I | -- | | 140 | R | -- | | D |
| PYRENE | 129000 | 0.03 | I | -- | | 105 | R | -- | | D |
| bis(2-ETHYLHEXYL) PHTHALATE | 117817 | 0.02 | I | 0.003 | CAL | 70 | R | 0.0000024 | CAL | B2 |
| **Pesticides/Herbicides** | | | | | | | | | | |
| 2,4,5-T (TRICHLOROPHENOXYACETIC ACID) | 93765 | 0.01 | I | -- | | 35 | R | -- | | -- |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2,4,5-TRICHLOROPHENOL | 95954 | 0.1 | I | -- | | 350 | R | -- | | -- |
| ALPHA BHC (ALPHA HEXACHLOROCYCLOHEXANE) | 319846 | 0.0005 | E | 2.7 | CAL | 1.75 | R | 0.00077 | CAL | B2 |
| ALPHA ENDOSULFAN | 115297 | 0.006 | I | -- | | 21 | R | -- | | -- |
| DALAPON | 75990 | 0.03 | I | -- | | 105 | R | -- | | -- |
| DINOSEB | 88857 | 0.003 | I | -- | | 10.5 | R | -- | | D |
| HEPTACHLOR | 76448 | 0.0005 | I | 4.1 | CAL | 1.75 | R | 0.0013 | I | B2 |
| HEXACHLOROBENZENE | 118741 | 0.0008 | I | 1.8 | CAL | 2.8 | R | 0.00051 | CAL | B2 |
| METHOXYCHLOR | 72435 | 0.005 | I | -- | | 17.5 | R | -- | | D |
| PENTACHLOROPHENOL | 87865 | 0.03 | I | 0.081 | CAL | 105 | R | 0.0000046 | CAL | B2 |
| p,p'-DDD | 72548 | -- | | 0.24 | CAL | -- | | 0.000069 | CAL | B2 |
| p,p'-DDE | 72559 | -- | | 0.34 | CAL | -- | | 0.000097 | CAL | B2 |
| p,p'-DDT | 50293 | 0.0005 | I | 0.34 | CAL | 1.75 | R | 0.000097 | CAL | B2 |
| **Inorganics** | | | | | | | | | | |
| ALUMINUM | 7429905 | I | E | -- | | 4.9 | E | -- | | -- |
| ANTIMONY | 7440360 | 0.0004 | I | -- | | -- | | -- | | -- |
| ARSENIC | 7440382 | 0.0003 | CAL | 1.5 | CAL | 0.03 | CAL | 0.0033 | CAL | A |
| BARIUM | 7440393 | 0.07 | I | -- | | 0.49 | H | -- | | D |
| BERYLLIUM | 7440417 | 0.002 | CAL | -- | | 0.007 | CAL | 0.0024 | CAL | B1 |
| CADMIUM | 7440439 | 0.0005 | CAL | 0.38 | CAL | 0.02 | CAL | 0.0042 | CAL | -- |
| CHROMIUM, HEXAVALENT | 18540299 | 0.02 | CAL | -- | | 0.2 | CAL | 0.15 | CAL | A & D |
| CHROMIUM, TOTAL[k/] | 7440473 | 0.021 | I | -- | | 0.7 | I | 0.00171 | I | A |
| COBALT | 7440484 | 0.02 | E | -- | | 0.0202 | E | 0.0028 | E | -- |
| COPPER | 7440508 | 0.04 | H | -- | | -- | | -- | | D |
| LEAD[l/] | 7439921 | -- | | -- | NU | -- | | -- | NU | B2 |
| MANGANESE | 7439965 | 0.14 | I | -- | | 0.2 | CAL | -- | | D |
| MERCURY | 7439976 | 0.0003 | CAL | -- | | 0.09 | CAL | -- | | C |
| MOLYBDENUM | 7439987 | 0.005 | I | -- | | -- | | -- | | -- |
| NICKEL | 7440020 | 0.05 | CAL | -- | | 0.05 | CAL | 0.00026 | CAL | -- |
| SELENIUM | 7782492 | 0.005 | I | -- | | 20 | CAL | -- | | D |
| SILVER | 7440224 | 0.005 | I | -- | | -- | | -- | | D |
| THALLIUM | 7440280 | 0.00008 | I | -- | | -- | | -- | | -- |
| VANADIUM | 7440622 | 0.007 | H | -- | | -- | | -- | | -- |
| ZINC | 7440666 | 0.3 | I | -- | | -- | | -- | | D |
| **Expolosives** | | | | | | | | | | |
| 2,6-DINITROTOLUENE[m/] | 606202 | 0.001 | H | 0.68 | I | 3.5 | R | -- | | B2 |

[a/] Parameters defined as: CSFo = Oral cancer slope factor; RfDo = Oral reference dose; URF = Unit risk factor; RfC = Reference concentration.

[b/] COPC = Chemical of potential concern.

[c/] CAS = Chemical abstracts service number.

[d/] mg/Kg-d = Milligram per kilogram per day.

[e/] Ref = References; I = USEPA (2003), Integrated Risk Information System (IRIS); H = USEPA (1997) Health Effects Assessment Summary Tables (HEAST); E = USEPA National Environmental Assessment per USEPA Region 9 (2002); CAL = California EPA limit.

[f/] $\mu g/m^3$ = Micrograms per cubic meter.

[g/] Based on USEPA cancer classifications (or International Agency for Research on Cancer [IARC] if USEPA classifications were unavailable). Refer to USEPA (2003) at www.epa.gov/iris/carcino.htm or IARC's web page (http://monographs.iarc.fr/monoeval/eval.html) for definitions of the reported cancer classifications.

[h/] -- = Data unavailable.

[i/] Toxicity values for total xylenes were used for all isomers.

[j/] Toxicity data for anthracene were used as surrogate values for phenanthrene.

[k/] Chromium, total is assumed to consist of CrVI:CrIII at a ratio of 1:6 (USEPA Region 9, 2002) and the toxicity values have been adjusted accordingly.

[l/] Toxicity criteria were not available for lead and it was evaluated separately using DTSC (2000) and/or USEPA (1994 and/or 1996) guidance.

[m/] The CSFo for 2,4/2,6-dinitrotoluene mixture was used for each isomer.

TABLE I-40

TOXICITY DATA FOR CHEMICALS OF POTENTIAL CONCERN
SITE - 1111
OU5 RI, MCB CAMP PENDLETON, CA

| | | Parameter Value [a] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| COPC [b] | CAS Number [c] | RfDo (mg/kg-d) [d] | Ref [e] | CSFo (mg/kg-d)$^{-1}$ | Ref | RfC (µg/m$^3$) [f] | Ref | URF (µg/m$^3$)$^{-1}$ [f] | Ref | Cancer Class [g] |
| **Volatile Organic Compounds** | | | | | | | | | | |
| 1,1,2,2-TETRACHLOROETHANE | 79345 | 0.06 | E | 0.2 | I | – [h] | | 0.000058 | I | C |
| 1,1,2-TRICHLOROETHANE | 79005 | 0.004 | I | 0.057 | I | – | | 0.000016 | I | C |
| 1,1-DICHLOROETHENE | 75354 | 0.05 | I | – | | 200 | I | – | | C |
| 1,2,4-TRIMETHYLBENZENE | 95636 | 0.05 | E | – | | 5.95 | E | – | | – |
| 1,2-DICHLOROETHANE | 107062 | 0.03 | E | 0.091 | I | 4.9 | E | 0.000026 | I | B2 |
| 1,3,5-TRIMETHYLBENZENE (MESITYLENE) | 108678 | 0.05 | E | – | | 5.95 | E | – | | – |
| ACETONE | 67641 | 0.9 | I | – | | – | | – | | D |
| BENZENE | 71432 | 0.004 | I | 0.055 | I | 30 | I | 0.0000078 | I | A |
| CHLOROFORM | 67663 | 0.01 | I | – | | 3.01 | E | 0.000023 | I | B2 |
| ETHYLBENZENE | 100414 | 0.1 | I | – | | 1000 | I | 0.0000011 | E | D |
| FLUORENE | 86737 | 0.04 | I | – | | – | | – | | D |
| ISOPROPYLBENZENE (CUMENE) | 98828 | 0.1 | I | – | | 400 | I | – | | D |
| M,P-XYLENE (SUM OF ISOMERS) [i] | 1330207 | 0.2 | I | – | | 100 | I | – | | 3 |
| METHYL ETHYL KETONE (2-BUTANONE) | 78933 | 0.6 | I | – | | 5000 | I | – | | D |
| METHYL ISOBUTYL KETONE (4-METHYL-2-PENTANONE) | 108101 | 0.08 | H | – | | 3 | I | – | | – |
| METHYLENE CHLORIDE | 75092 | 0.06 | I | 0.0075 | I | 3010 | H | 4.7E-07 | I | B2 |
| NAPHTHALENE | 91203 | 0.02 | I | – | | 3 | I | – | | C |
| O-XYLENE (1,2-DIMETHYLBENZENE) [i] | 1330207 | 0.2 | I | – | | 100 | I | – | | 3 |
| P-CYMENE (p-ISOPROPYLTOLUENE) | 99876 | – | | – | | – | | – | | – |
| PHENANTHRENE [j] | 85018 | 0.3 | I | – | | – | | – | | D |
| SEC-BUTYLBENZENE | 135988 | 0.04 | E | – | | – | | – | | D |
| TETRACHLOROETHYLENE (PCE) | 127184 | 0.01 | I | 0.052 | E | 595 | E | 2.86E-06 | E | 2A |
| TOLUENE | 108883 | 0.2 | I | – | | 400 | I | – | | D |
| TRICHLOROETHYLENE (TCE) | 79016 | 0.0003 | E | 0.4 | E | 35 | E | 0.000114 | E | 2A |
| cis-1,2-DICHLOROETHYLENE | 156592 | 0.01 | H | – | | – | | – | | D |
| n-PROPYLBENZENE | 103651 | 0.04 | E | – | | – | | – | | – |
| tert-BUTYL METHYL ETHER | 1634044 | – | | 0.0033 | E | 3000 | I | 0.0000001 | E | – |
| trans-1,2-DICHLOROETHENE | 156605 | 0.02 | I | – | | – | | – | | – |
| **Semivolatile Organic Compounds** | | | | | | | | | | |
| 2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN | 1746016 | – | | 150000 | H | – | | 42.9 | H | 1 |
| CHRYSENE | 218019 | – | | 0.0073 | E | – | | – | | B2 |
| FLUORANTHENE | 206440 | 0.04 | I | – | | – | | – | | D |
| PYRENE | 129000 | 0.03 | I | – | | – | | – | | D |
| bis(2-ETHYLHEXYL) PHTHALATE | 117817 | 0.02 | I | 0.014 | I | – | | – | | B2 |
| **Pesticides/Herbicides** | | | | | | | | | | |
| 2,4,5-T (TRICHLOROPHENOXYACETIC ACID) | 93765 | 0.01 | I | – | | – | | – | | – |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2,4,5-TRICHLOROPHENOL | 95954 | 0.1 | I | – | | – | | – | | – |
| ALPHA BHC (ALPHA HEXACHLOROCYCLOHEXANE) | 319846 | 0.0005 | E | 6.3 | I | – | | 0.0018 | I | B2 |
| ALPHA ENDOSULFAN | 115297 | 0.006 | I | – | | – | | – | | – |
| DALAPON | 75990 | 0.03 | I | – | | – | | – | | – |
| DINOSEB | 88857 | 0.003 | I | – | | – | | – | | D |
| HEPTACHLOR | 76448 | 0.0005 | I | 4.5 | I | – | | 0.0013 | I | B2 |
| HEXACHLOROBENZENE | 118741 | 0.0008 | I | 1.6 | I | – | | 0.00046 | I | B2 |
| METHOXYCHLOR | 72435 | 0.005 | I | – | | – | | – | | D |
| PENTACHLOROPHENOL | 87865 | 0.03 | I | 0.12 | I | – | | – | | B2 |
| p,p'-DDD | 72548 | – | | 0.24 | I | – | | – | | B2 |
| p,p'-DDE | 72559 | – | | 0.34 | I | – | | – | | B2 |
| p,p'-DDT | 50293 | 0.0005 | I | 0.34 | I | – | | 0.000097 | I | B2 |
| **Inorganics** | | | | | | | | | | |
| ALUMINUM | 7429905 | I | E | – | | 4.9 | E | – | | – |
| ANTIMONY | 7440360 | 0.0004 | I | – | | – | | – | | – |
| ARSENIC | 7440382 | 0.0003 | I | 1.5 | I | – | | 0.0043 | I | A |
| BARIUM | 7440393 | 0.07 | I | – | | 0.49 | H | – | | D |
| BERYLLIUM | 7440417 | 0.002 | I | – | | 0.02 | I | 0.0024 | I | B1 |
| CADMIUM | 7440439 | 0.001 | I | – | | – | | 0.0018 | I | – |
| CHROMIUM, HEXAVALENT | 18540299 | 0.003 | I | – | | 0.1 | I | 0.0012 | I | A & D |
| CHROMIUM, TOTAL[k/] | 7440473 | 0.021 | I | – | | 0.7 | I | 0.00171 | I | A |
| COBALT | 7440484 | 0.02 | E | – | | 0.0202 | E | 0.0028 | E | – |
| COPPER | 7440508 | 0.04 | H | – | | – | | – | | D |
| LEAD[l/] | 7439921 | – | | – | | – | | – | | B2 |
| MANGANESE | 7439965 | 0.14 | I | – | | 0.05 | I | – | | D |
| MERCURY | 7439976 | 0.0003 | I | – | | – | | – | | C |
| MOLYBDENUM | 7439987 | 0.005 | I | – | | – | | – | | – |
| NICKEL | 7440020 | 0.02 | I | – | | – | | – | | – |
| SELENIUM | 7782492 | 0.005 | I | – | | – | | – | | D |
| SILVER | 7440224 | 0.005 | I | – | | – | | – | | D |
| THALLIUM | 7440280 | 0.00008 | I | – | | – | | – | | – |
| VANADIUM | 7440622 | 0.007 | H | – | | – | | – | | – |
| ZINC | 7440666 | 0.3 | I | – | | – | | – | | D |
| **Expolosives** | | | | | | | | | | |
| 2,6-DINITROTOLUENE[m/] | 606202 | 0.001 | H | 0.68 | I | – | | – | | B2 |

[a/] Parameters defined as: CSFo = Oral cancer slope factor; RfDo = Oral reference dose; URF = Unit risk factor; RfC = Reference concentration.

[b/] COPC = Chemical of potential concern.

[c/] CAS = Chemical abstracts service number.

[d/] mg/Kg-d = Milligram per kilogram per day.

[e/] Ref = References; I = USEPA (2003), Integrated Risk Information System (IRIS); H = USEPA (1997) Health Effects Assessment Summary Tables (HEAST); E = USEPA National Environmental Assessment per USEPA Region 9 (2002).

[f/] $\mu g/m^3$ = Micrograms per cubic meter.

[g/] Based on USEPA cancer classifications (or International Agency for Research on Cancer [IARC] if USEPA classifications were unavailable). Refer to USEPA (2003) at www.epa.gov/iris/carcino.htm or IARC's web page (http://monographs.iarc.fr/monoeval/eval.html) for definitions of the reported cancer classifications.

[h/] – = Data unavailable.

[i/] Toxicity values for total xylenes were used for all isomers.

[j/] Toxicity data for anthracene were used as surrogate values for phenanthrene.

[k/] Chromium, total is assumed to consist of CrVI:CrIII at a ratio of 1:6 (USEPA Region 9, 2002) and the toxicity values have been adjusted accordingly.

[l/] Toxicity criteria were not available for lead and it was evaluated separately using DTSC (2000) and/or USEPA (1994 and/or 1996) guidance.

[m/] The CSFo for 2,4/2,6-dinitrotoluene mixture was used for each isomer.

# APPENDIX E
# TIER-3 EVALUATION OF REMEDIAL ALTERNATIVES
# DERIVATION OF PRELIMINARY REMEDIATION GOALS
# FOR ECOLOGICAL RESOURCES

# EXECUTIVE SUMMARY

Ecological risk assessments (ERA) of sites in Operable Unit (OU) 5 of Marine Corps Base (MCB) Camp Pendleton (the Base) were previously conducted as part of an ongoing Remedial Investigation (RI) to address potential contamination at the Base (Parsons, 2004). The RI concluded that several chemicals are present at concentrations that are predicted to pose a potentially significant hazard to one or more ecological receptors at Site 1A-1 (antimony, lead, zinc, and dioxins[1]) and at Site 1111 (antimony, mercury, dioxins, and hexachlorobenzene). In accordance with United States Environmental Protection Agency (USEPA) and United States Navy (US Navy) guidance (USEPA, 1997; US Navy, 1999a,b,c,d,e), these chemicals require additional consideration for remedy development in a Tier-3 assessment (Evaluation of Remedial Alternatives).

This report presents the derivation of preliminary remediation goals (PRGs) for ecological resources (ecoPRGs) that are protective of the resources potentially at-risk at Site 1A-1 and at Site 1111, and documents the compliance with risk-management objectives for a voluntary interim remedial measure (a removal action) at Site 1111.

The site-specific ecoPRGs are:

- **Site 1A-1**
  - Antimony: 16 mg/kg
  - Lead: 73 mg/kg
  - Zinc: 254 mg/kg
  - Dioxins: 4.4E-05 mg/kg (44 pg/g)
- **Site 1111**
  - Antimony: 12 mg/kg
  - Mercury: 8.5 mg/kg
  - Dioxins: 4.4E-05 mg/kg (44 pg/g)
  - Hexachlorobenzene: 0.65 mg/kg.

These ecoPRGs provide one line of information for consideration, with respect to the nine CERCLA remedy evaluation criteria identified in the National Contingency Plan [NCP; 40CFR 300.430(e)(9)(iii)] during the Tier-3 Evaluation of Remedial Alternatives process.

[1] Dioxins include the 2,3,7,8-substituted polychlorinated dibenzo-*p*-dioxins and dibenzofurans.

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Table E4-5 Summary of Receptor-Specific Ecological Preliminary Remediation Goals, Site 1111

# ACRONYMS

| | |
|---|---|
| 95%UCL | 95th-percentile upper-confidence-limit on the mean |
| bgs | below ground surface |
| BERA | baseline ecological risk assessment |
| COPC | chemical of potential concern |
| CSM | conceptual site model |
| dw | dry weight |
| ecoPRG | ecological PRG |
| EPC | exposure-point concentration |
| ERA | ecological risk assessment |
| HQ | hazard quotient |
| MCB | Marine Corps Base |
| mg/kg | milligrams per kilogram |
| NCP | National Contingency Plan |
| OU | operable unit |
| PRG | preliminary remediation goal |
| RI | remedial investigation |
| SRA | screening risk assessment |
| TCDD | tetrachlorodibenzo-p-dioxin |
| TEQ | toxicity equivalent |
| TRV | toxicity reference value |
| USEPA | United States Environmental Protection Agency |

## E1.0 INTRODUCTION

Ecological risk assessments (ERA) of sites in Operable Unit (OU) 5 of Marine Corps Base (MCB) Camp Pendleton (the Base) were previously conducted as part of an ongoing Remedial Investigation (RI) to address potential contamination at the Base (Parsons, 2004). The RI concluded that several chemicals are present at concentrations that are predicted to pose a potentially significant hazard to one or more ecological receptors at Site 1A-1 (antimony, lead, zinc, and dioxins[2]) and at Site 1111 (antimony, mercury, dioxins, and hexachlorobenzene). In accordance with United States Environmental Protection Agency (USEPA) and United States Navy (US Navy) guidance (USEPA, 1997; US Navy, 1999a–e), risk-management decisions were made that these chemicals require additional consideration for remedy development in a Tier-3 assessment (Evaluation of Remedial Alternatives).

This report presents the derivation of preliminary remediation goals (PRGs) that are protective of ecological resources (ecoPRGs) potentially at-risk at Site 1A-1 and at Site 1111, and documents the compliance with risk-management objectives assuming that contaminated soils are removed from Site 1111. The soils to be removed at Site 1111, as described in Section 4.6.2.3, are herein referred to as hot-spot soils.

The primary objectives of the ecological risk assessments previously conducted for these sites at the Base were to characterize ecological risks posed by site-related chemicals of potential concern (COPCs) and support remedial decisions regarding the need for remediation. The objectives of a Tier-3 evaluation are to evaluate alternative remedies for risk reduction and to support the selection of a preferred remedy. In support of the Tier-3 evaluation, this report:

- develops ecological PRGs to ensure protection of ecological resources if removal actions are chosen as the selected remedy for Site 1A-1;
- demonstrates compliance of residual risk at Site 1111 with risk-management goals, following removal of hot-spot soils; and
- develops ecological PRGs to ensure protection of ecological resources, confirmed by follow-up sampling conducted during the removal of hot-spot soils, in support of close-out decisions for "no further ecological investigation" at Site 1111.

### E1.1 Tiered Approach to Ecological Risk Assessment in Support of Remedy Development

US Navy policy (US Navy, 1999a–e) for conducting ecological risk assessments outlines a three-tiered approach to characterizing ecological hazards at contaminated sites:

- **Tier 1 – Screening-Level Ecological Risk Assessment (SRA):** The Tier-1 SRA for the OU 5 sites employed existing site data and protective ("conservative") assumptions to support decision(s) for (a) no further action, (b) further analysis in Tier 2, or (c) accelerated site remediation. Based on the potential for bioaccumulation or the screening ecotoxicity values exceeding the maximum detected concentrations of Tier-1 COPCs in soil, there were COPCs in

[2] "dioxins" include the 2,3,7,8-substituted polychlorinated dibenzo-*p*-dioxins and dibenzofurans.

soil at Site 1A-1 and at Site 1111 that warranted further evaluation in a Tier-2 Baseline Ecological Risk Assessment.

- **Tier 2 – Baseline Ecological Risk Assessment (BERA):** For those chemicals that were identified by the Tier-1 SRA as warranting further analysis, the Tier-2 BERA provided a scientifically based, defensible re-assessment of exposures and hazards at locations identified in the Tier-1 SRA. It employed less-conservative assumptions, yet developed more-realistic, site-specific estimates of potential ecological hazards in support of a decision that, from an ecological perspective, further evaluation of select COPCs was warranted for Tier 3.
- **Tier 3 – Evaluation of Remedial Alternatives:** Tier 3 evaluations focus on identifying a site-specific remedy that reduces ecological risk to acceptable levels. The Evaluation of Remedial Alternatives would also include, if warranted, discussions between Base and regulatory-agency staff to ensure that any remedial action be implemented in accordance with the Base's mission and with agency requirements (e.g., a Section 7 consultation with resource-agency staff may be appropriate to ensure protection of special-status species).

## E1.2 Report Organization

The major subdivisions of this report include:

- **Section 1 – Introduction;**
- **Section 2 – Summary of Tier-1 and Tier-2 Ecological Risk Assessments:** This section presents a brief summary of the important elements of ERA developed for the RI (Parsons, 2004);
- **Section 3 – Site 1A-1:** This section develops ecological PRGs that demonstrate protection of ecological resources, as one component for risk managers to consider during the evaluation of remedial alternatives;
- **Section 4 – Site 1111:** This section demonstrates compliance with risk-management objectives (assuming removal of hot-spot soils is implemented), and develops ecological PRGs that demonstrate protection of ecological resources, as one component for risk managers to consider during the evaluation of remedial alternatives; and
- **Section 5 – References:** references cited within this report.

## E2.0 SUMMARY OF THE ECOLOGICAL RISK ASSESSMENTS AND DEVELOPMENT OF PRGS

The US Navy's tiered approach to ERA was implemented within an overall conceptual framework for ERA developed initially by the USEPA (1992). Three principal steps of ERAs, as more-recently formalized (USEPA, 1997 and 1998), are problem formulation, analysis, and risk characterization. The details of the ERAs for Site 1A-1 and Site 1111 are provided in the RI (Appendix K, Parsons, 2004), but are briefly summarized below. The significant results of the ERAs then form the basis for the Tier-3 Assessment and development of ecological PRGs.

### E2.1 Problem Formulation

Problem Formulation for the Tier-1 and Tier-2 ERAs included site characterization, receptor selection, identification and characterization of chemicals present at the location, and specification of Conceptual Site Models (CSMs). Sites 1A-1 and 1111 both are areas of habitat potentially utilized by organisms (ecological receptors) that may, in turn, be exposed to site-related contaminants. Thus, there are complete pathways for the potential exposure of receptors to site-related chemicals, and a quantitative analysis and risk-characterization were performed in accordance with the site-specific CSMs.

### E2.2 Analysis

The Analysis phase of the ERAs included characterization of exposures and characterizations of ecological effects, and was based on the site-specific CSMs and assessment endpoints identified for these sites. The Exposure Characterizations quantified the concentrations or doses that receptors might encounter, based on the analytical results from soil samples collected from each site. The Effects Characterizations quantified the relationships between the concentration of a chemical and the potential for occurrence of adverse ecological effects in organisms, but was derived using literature-based toxicity information (not site-specific studies of environmental toxicity).

### E2.3 Risk Characterization

Risk Characterization was the final process of ERAs, and involved three components: 1) risk estimation (an expression of the relationship between estimated site-specific exposures and the literature-based toxicity information), 2) uncertainty characterization (identification of key assumptions intrinsic to the process, and their influence), and 3) risk interpretation (integration of risk estimation, uncertainty, and information to support conclusions). Collectively, these steps were used to present the risk estimates in a scientific context for supporting the remedial decisions.

Based on the analyses conducted through Tiers 1 and 2 of the ERAs for the RI (Appendix K, Parsons, 2004), several chemicals are present at concentrations that were predicted to pose a potentially significant hazard to one or more ecological receptors:

- **Site 1A-1:** Inorganics (antimony, lead, and zinc) and dioxins; and
- **Site 1111:** Inorganics (antimony and mercury), dioxins, and hexachlorobenzene.

In accordance with guidance-directed conclusion options from the Tier-1 and Tier-2 ERAs, these COPCs require additional consideration for remedy development in a Tier-3 assessment, including the development of PRGs.

## E2.4 Ecological PRGs

PRGs are risk-based media concentrations that represent target concentrations around which remedy development can begin (US Navy, 1999e). In accordance with the US Navy guidance (1999e), the exposure and effects information used in the Tier-2 BERAs can be used to develop a bounding range of concentrations for PRGs. Using the identical exposure algorithms and the no-effect and effect-based toxicity reference values (TRVs) used in the Tier-2 BERAs, risk-estimation equations can be "back-calculated" for the soil concentration that would result in a Tier-2 hazard quotient (HQ) value equal to the indicator threshold of 1.0. This process is simply the reverse of the "forward calculations" presented in the ERAs, in which a soil concentration enters the equations and the risk estimate is the outcome. The (receptor-specific) exposure portion of the risk-estimation equation would be identical regardless of the TRV, but the soil concentration giving rise to an HQ of 1 based on a no-effect TRV would represent a lower-bound estimate, below-which further remediation is not warranted for any exposure-point concentration. The PRG derived using an effect-based TRV would indicate an upper-bound limit above which further remediation might be necessary, if the exposure-point concentration for the area were greater than the PRG value. Exposure, for many receptors and particularly for wildlife, occurs over an exposure area, such that single-point concentrations of a chemical might be greater than a PRG value, but the overall integrated exposure estimate (e.g., a 95% upper confidence limit [UCL] for an exposure area) might be sufficiently protective against ecological hazards. Soil concentrations that fall between these limits might, or might not, indicate an unacceptable potential for ecological hazard, but such conclusions would require further explanation based on site-specific information.

The value selected as a site- and chemical-specific ecological PRG is the lowest of the ecoPRGs for any wildlife receptor, derived using an effect-based TRV. The rationale is that if the maximum residual concentration is at or below the ecoPRG, then the exposure for a population of mobile receptors within that area would never be at concentrations greater than the PRG and the exposure-point concentration (e.g., the 95%UCL) would always be within an acceptable range of concentrations that would not result in effect-based HQ values greater than one.

## E3.0 SITE 1A-1

Site 1A-1 is a debris- and waste-disposal area approximately 800 feet northeast of Site 1A (a former waste burn pit addressed under OU 3). Site 1A-1 is located in an area of mixed sagebrush, arroyo willow/black willow, and ruderal (weedy, disturbed) vegetative communities, as indicated in a report for the nearby Site 1A (IT, 1999). The common plant species of the mixed sagebrush series include white and black sagebrush (*Artemisia spp.*), coyotebush, and buckwheat (*Eriogonum spp.*). The site itself, approximately 3 acres in size, is predominantly coastal sage scrub, with riparian woodland occurring along a nearby stream course. A few willow and sycamore trees are present. Disturbed habitat consists primarily of bare ground (primarily roadways), sparsely vegetated with mustard or non-native grasses (IT, 1999). The California coastal gnatcatcher and the least Bell's vireo (IT, 1999) and the southwestern willow flycatcher (MCB Camp Pendleton, 2001) are special-status species known to have been present near Site 1A-1.

### E3.1 Site-Related COPCs

Thirty-seven samples were collected from soil less than 6 feet below ground surface (bgs) at Site 1A-1 and analyzed for a suite of inorganic and organic constituents, including dioxins. Based on the Tier-1 and Tier-2 ERAs (Appendix K, Parsons, 2004), the following were identified warranting Tier-3 evaluation:

- **Inorganics:**
  - antimony – is present at an average concentration of 7.5 mg/kg (ranging from 0.81 mg/kg to 57.5 mg/kg) in 0 to 1.5 feet bgs, and is present at an average concentration of 12.8 mg/kg (ranging from 0.81 mg/kg to 108 mg/kg) in 0 to 5 feet bgs. The exposure-point concentrations that triggered the Tier-3 evaluation were 95%UCLs on the mean equal to 13.5 mg/kg for the 0 to 1.5 feet bgs interval and at 19.3 mg/kg for the 0 to 5 feet bgs interval;
  - lead – is present at an average concentration of 609 mg/kg (ranging from 1.3 mg/kg to 7130 mg/kg) in 0 to 1.5 feet bgs, and is present at an average concentration of 918 mg/kg (ranging from 1.3 mg/kg to 9670 mg/kg) in 0 to 5 feet bgs. The 95%UCL exposure-point concentrations were 1240 mg/kg (0 to 1.5 feet bgs) and 1470 mg/kg (0 to 5 feet bgs);
  - zinc – is present at an average concentration of 990 mg/kg (ranging from 19.2 mg/kg to 8650 mg/kg) in 0 to 1.5 feet bgs, and is present at an average concentration of 1460 mg/kg (ranging from 11.5 mg/kg to 8650 mg/kg) in 0 to 5 feet bgs. The 95%UCL exposure-point concentrations were 1850 mg/kg (0 to 1.5 feet bgs) and 2180 mg/kg (0 to 5 feet bgs).
- **Dioxins** – are present in soil at maximum concentrations of $7.62\times10^{-3}$ mg/kg for the avian toxicity equivalent (TEQ) concentration and $2.85\times10^{-3}$ mg/kg for the mammalian TEQ concentration. These exposure-point concentrations were used as maximum concentrations because there was an insufficient number of samples to calculate 95%UCLs.

### E3.2 Development of Ecological PRGs

Tier-2 exposure-point concentrations, background concentrations, and receptor-specific PRGs for Site 1A-1 are presented in Table E3-1.

**Antimony:** Most of the no-effect PRGs are below the background concentration of 8.8 mg/kg, indicating the conservatism of the assessment, most likely in toxicity assessment (i.e., the laboratory-based toxicity information is not representative of real animals in the natural environment). The lowest of the effect-based ecoPRGs for wildlife is for the hypothetical exposures of deer mice, and is a value (16 mg/kg) about double the background concentration. The upper-bound limit for an acceptable exposure-point concentration (the ecoPRG) for antimony is approximately 16 mg/kg or less.

**Lead:** Most of the no-effect PRGs for wildlife are below the background concentration of 29.1 mg/kg, indicating the conservatism of the assessment, most likely in toxicity assessment (i.e., the laboratory-based toxicity information is not representative of real animals in the natural environment). The lowest no-effect PRG greater than background is for the invertivorous mammals (represented by the Southern grasshopper mouse), with a no-effect PRG concentration of 36 mg/kg. The lowest of the effect-based ecoPRGs for wildlife is for the hypothetical exposures of the invertivorous birds (represented by least Bell's vireo), at a concentration of 73 mg/kg. The upper-bound limit for an acceptable exposure-point concentration (the ecoPRG) for lead is approximately 73 mg/kg or less.

**Zinc:** All of the no-effect PRGs for wildlife with small home ranges are below the background concentration of 111 mg/kg, indicating the conservatism of the assessment, most likely in toxicity assessment (*i.e.*, the laboratory-based toxicity information is not representative of real animals in the natural environment), and perhaps excessively so for this essential nutrient. The lowest of the effect-based ecoPRGs for wildlife is for the hypothetical exposures of least Bell's vireo, and is a value (254 mg/kg) about double the background concentration. The upper-bound limit for an acceptable exposure-point concentration (the ecoPRG) for zinc is approximately 254 mg/kg or less. The nutritional needs of the wildlife receptors are not specifically known; however, the long-term maximum tolerable level of dietary zinc for domestic birds is 1000 mg/kg (NAS, 1980). For the least Bell's vireo (the most-sensitive receptor), the ecoPRG concentration in soil (254 mg/kg) would give rise to an estimated Tier-1 exposure dose of 109 $mg/kg_{BW}$–day and an estimated Tier-2 exposure dose of 172 $mg/kg_{BW}$–day, less than that maximum tolerable level.

**Dioxins:** The lowest of the no-effect PRGs for wildlife is $4.4 \times 10^{-6}$ mg/kg (4.4 pg/g) for the hypothetical exposure of the deer mice population to soil-borne dioxins; the lowest of the effect-based ecoPRGs is also for hypothetical exposure of the deer mice population, at a concentration of $4.4 \times 10^{-5}$ mg/kg (44 pg/g). The ten-fold difference in PRG values is strictly the result of the use of a ten-fold uncertainty factor applied to the same underlying toxicity data for the effect- and no-effect TRVs. The upper-bound limit for an acceptable exposure-point concentration for the dioxins (the ecoPRG) is approximately $4.4 \times 10^{-5}$ mg/kg (44 pg/g) or less.

## Table E3-1
## Site 1A-1
## Summary of Receptor-Specific Ecological Preliminary Remediation Goals
## MCB Camp Pendleton, California

| Tier-3 COC [1a] | Baseline Exposure-Point Concentration [1b] (*mg/kg dw*) 0- to 1.5-ft bgs | 0- to 5-ft bgs | Background Concentration [1c] (*mg/kg soil dw*) | Scenario-Specific [1d] Soil Concentration (*mg/kg dw*) that would result in an HQ = 1: Terrestrial Vegetation No-Effect | Soil Invertebrates and Microbial Processes No-Effect | Mammals: Pacific Pocket Mouse No-Effect | Pacific Pocket Mouse Effect | Deer Mouse No-Effect | Deer Mouse Effect | Southern Grasshopper Mouse No-Effect | Southern Grasshopper Mouse Effect | Gray Fox No-Effect | Gray Fox Effect |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inorganics | | | | | | | | | | | | | |
| Antimony | 13.5 (95%UCL) | 19.3 (95%UCL) | 8.8 | *5.0* | 78 | *5.7* | 28 | *3.3* | 16 | *5.4* | 27 | 16708 | 83541 |
| Lead | 1240 (95%UCL) | 1470 (95%UCL) | 29.1 | 110 | 1700 | 87 | 54164 | *22* | 17620 | 36 | 27986 | 83746 | [>100%] [1e] |
| Zinc | 1850 (95%UCL) | 2180 (95%UCL) | 111 | 50 | 100 | *60* | 29608 | *2.1* | 27879 | *5.3* | 110614 | 833114 | [>100%] [1e] |
| Polychlorinated Dibenzo-p-dioxins and dibenzofurans | | | | | | | | | | | | | |
| 2,3,7,8-TCDD TEQ (Bird) | 7.62E-03 (max) | 7.62E-03 (max) | Not Applicable | No Benchmark | No Benchmark | -- | -- | -- | -- | -- | -- | -- | -- |
| 2,3,7,8-TCDD TEQ (Mamm | 2.85E-03 (max) | 2.85E-03 (max) | Not Applicable | No Benchmark | No Benchmark | 1.9E-04 | 1.9E-03 | 4.4E-06 | 4.4E-05 | 5.7E-06 | 5.7E-05 | 8.5E-02 | 8.5E-01 |

[1a] Tier-3 chemical of ecological concern.
[1b] Exposure-point concentration used in the Tier-2 BERA (Appendix K, Parsons, 2004).
[1c] Santa Margarita Basin Background (SWDIV, 1997).
[1d] Scenario Features:
No-Effect: Area-Use-Factor- (AUF-) adjusted exposure; no-effect TRV; and
Effect: AUF-adjusted exposure; effect-based TRV.
[1e] The risk-estimation *computation* can result in a PRG value that is greater than one million parts per million (*i.e.* >100% pure compoud), which is an obvious impossibility.

*Shaded italicized values* indicate a PRG less than background.

## Table E3-1
## Site 1A-1
## Summary of Receptor-Specific Ecological Preliminary Remediation Goals
## MCB Camp Pendleton, California

| Tier-3 COC [1a] | Baseline Exposure-Point Concentration [1b] (*mg/kg dw*) 0- to 1.5-ft bgs | 0- to 5-ft bgs | Background Concentration [1c] (*mg/kg soil dw*) | Scenario-Specific [1d] Soil Concentration (*mg/kg dw*) that would result in an HQ = 1 — Birds: California Quail No-Effect | California Quail Effect | Horned Lark No-Effect | Horned Lark Effect | Least Bell's Vireo No-Effect | Least Bell's Vireo Effect | Red-tailed Hawk No-Effect | Red-tailed Hawk Effect |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inorganics | | | | | | | | | | | |
| Antimony | 13.5 (95%UCL) | 19.3 (95%UCL) | 8.8 | 126 | 378 | *6.0* | 18 | *1.94* | 5.8 | 13542 | 40626 |
| Lead | 1240 (95%UCL) | 1470 (95%UCL) | 29.1 | *5.9* | 20850 | *0.08* | 343 | *0.03* | 73 | 71 | 253226 |
| Zinc | 1850 (95%UCL) | 2180 (95%UCL) | 111 | 12256 | 321330 | *13* | 5114 | *0.24* | 254 | 512593 | [>100%] [1e] |
| Polychlorinated Dibenzo-p-dioxins and dibenzofurans | | | | | | | | | | | |
| 2,3,7,8-TCDD TEQ (Bird) | 7.62E-03 (max) | 7.62E-03 (max) | Not Applicable | 6.0E-03 | 6.0E-02 | 6.4E-05 | 6.4E-04 | 1.6E-05 | 1.6E-04 | 4.0E-01 | 4.0E+00 |
| 2,3,7,8-TCDD TEQ (Mamm | 2.85E-03 (max) | 2.85E-03 (max) | Not Applicable | -- | -- | -- | -- | -- | -- | -- | -- |

[1a] Tier-3 chemical of ecological concern.
[1b] Exposure-point concentration used in the Tier-2 BERA (Appendix K, Parsons, 2004).
[1c] Santa Margarita Basin Background (SWDIV, 1997).
[1d] Scenario Features:
No-Effect: Area-Use-Factor- (AUF-) adjusted exposure; no-effect TRV; and
Effect: AUF-adjusted exposure; effect-based TRV.
[1e] The risk-estimation *computation* can result in a PRG value that is greater than one n parts per million (*i.e.* >100% pure compoud), which is an obvious impossibility.

*Shaded italicized values* indicate a PRG less than background.

## E4.0 SITE 1111 ERA

Site 1111 is a location adjacent to the Former Pest-Control Washrack (IRP Site 3), near the Santa Margarita River. Site 1111 is less than one-half mile from the Santa Margarita River, and lies along a southwesterly flowing drainage that does empty to the river. The potentially affected area is approximately one acre. The site has been extensively sampled to characterize the lateral extent of contamination, and data to date do not indicate transport of contaminated soil to the river in this relatively flat area. This site is topographically level, and there are topographically elevated areas between the site and the Santa Margarita River, such that lateral movement of chemicals from site soil to the river is not likely. The site itself is in an area of coastal sage scrub and disturbed habitat (primarily non-native grassland), and lies adjacent to the riparian woodland along the Santa Margarita River. The riparian habitat along the Santa Margarita River supports a diverse community of bird, mammalian, amphibian, and reptilian wildlife. Approximately 10 to 20 mammal species and 80 resident and migratory bird species may regularly use the river corridor and might reasonably be expected to utilize the site. Eight to ten species of amphibian and reptiles probably occur in the site vicinity, including western toad (*Bufo boreas*) and common king snake (*Lampropeltis getulus*). The adjacent riparian habitats of the Santa Margarita River support threatened, endangered, or special-status wildlife species, including the arroyo toad, Pacific pocket mouse, southwestern pond turtle, least Bell's vireo, coastal California gnatcatcher, and southwestern willow flycatcher (SWDIV, 1993). To date, remedial activities at Site 1111 have been restricted to times outside of the breeding season for special-status birds and have had to avoid potential habitat for the arroyo toad. The undisturbed, unremediated area at and around Site 1111 is habitat for the arroyo toad, and is known to have hosted nesting least Bell's vireos and southwestern willow flycatchers; vegetation has been removed in the disturbed, remediated portion of Site 1111.

### E4.1 Site-Related COPCs

As many as 98 samples were collected from soil less than 6 feet bgs at Site 1111 and analyzed for a suite of inorganic and organic constituents, including dioxins. Based on the Tier-1 and Tier-2 ERAs (Appendix K, Parsons, 2004), the following were identified warranting Tier-3 evaluation:

- **Inorganics:**
  - antimony – is present at an average concentration of 57.6 mg/kg (ranging from 0.22 mg/kg to 2260 mg/kg) in 0 to 1.5 feet bgs, and is present at an average concentration of 69.3 mg/kg (ranging from 0.22 mg/kg to 3210 mg/kg) in 0 to 5 feet bgs. The 95%UCL exposure-point concentrations were 170 mg/kg for 0 to 1.5 feet bgs and 3210 mg/kg for 0 to 5 feet bgs;
  - mercury – is present at an average concentration of 0.332 mg/kg (ranging from 0.013 mg/kg to 1.24 mg/kg) in 0 to 1.5 feet bgs soil, and is present at an average concentration of 33.5 mg/kg (ranging from 0.013 mg/kg to 3220 mg/kg) in 0 to 5 feet bgs. The 95%UCL exposure-point concentrations were 0.712 mg/kg for 0 to 1.5 feet bgs and 67.0 mg/kg for 0 to 5 feet bgs.
- **Dioxins** – are present at exposure-point concentrations of $1.82\times10^{-4}$ mg/kg for the avian TEQ concentration and $1.34\times10^{-4}$ mg/kg for the mammalian TEQ concentration in 0 to 1.5 feet bgs (both are maximum concentrations due to an insufficient number of samples for calculation of 95%UCLs), and are present at 95%UCL exposure-point concentrations of $1.10\times10^{-2}$ mg/kg for the avian TEQ concentration and $9.27\times10^{-3}$ for the mammalian TEQ concentration in 0 to 5 feet bgs.

- **Semivolatile Organic Compounds:** hexachlorobenzene is present at an average concentration of 0.36 mg/kg (ranging from .0001 mg/kg to 1.8 mg/kg) in 0 to 1.5 feet bgs, and is present at an average concentration of 0.18 mg/kg (ranging from 0.0001 mg/kg to 1.8 mg/kg) in 0 to 5 feet bgs. The exposure-point concentrations are a maximum concentration of 1.8 mg/kg for 0 to 1.5 feet bgs, and 95%UCL concentration of 0.54 mg/kg for 0 to 5 feet bgs.

## E4.2 Removal of Hot-Spot Soils and Compliance with Risk-Management Targets

As indicated in the RI (Parsons, 2004), there is a defined area of soil (approximately 1,100 yards) at Site 1111 that contains significantly higher concentrations of COCs than the surrounding soils. This area is referred to as hot-spot soils. Removal of the hot-spot soils is considered in the remedial alternatives evaluated in this FS.

One option under consideration is the removal of hot-spot soils to mitigate potential threats to human health and the groundwater resource. If this removal were to occur, then the "conditions" evaluated in the Tier-2 BERA would no longer reflect the Site 1111 environment. To evaluate the potential effectiveness of such a removal, with respect to protection of ecological resources, the Site 1111 data were re-evaluated as if the removal had occurred (i.e., a "virtual remediation"). The samples within the area to be excavated were excluded from the Site 1111 data (see, for example, figures in Section 5 of the RI; Parsons, 2004), and exposure-point concentrations were re-calculated and re-run through the Tier-1 and Tier-2 ERA process. Samples from locations 1111B04, 1111B05, 1111MW-3, and 1111SB-02, -05, -06, -07, -08, -09, -9A, -17, -18, -19, and -32 were removed from the data set and summary statistics were regenerated (Table E4-1 [0 to 1.5 feet bgs] and Table E4-2 [0 to 5 feet bgs]). The "post-excavation" exposure-point concentrations were evaluated using the same computational approach as provided in the Tier-2 BERA; the summary results are provided in Table E4-3 (a Tier-1 evaluation of Tier-3 COPCs) and Table E4-4 (a Tier-2 evaluation of Tier-3 COPCs).

As Table E4-1 and Table E4-2 indicate, all detections of dioxins occurred in samples from the excavation area, and there are no residual detected concentrations for the "post-excavation" analysis. Thus, dioxins are no longer chemicals of concern for Site 1111 if the subject soils were to be removed to a depth of at least 5 feet bgs. As Table E4-3 indicates, the residual ("post-excavation") exposure-point concentration of antimony, 8.4 mg/kg, is below the background concentration, 8.8 mg/kg; therefore, antimony is also no longer a chemical of concern for Site 1111 if the subject soils were to be removed to a depth of at least 5 feet bgs.

If the "post-excavation" concentrations of mercury and hexachlorobenzene are evaluated in a Tier-2 assessment, then the concentrations of hexachlorobenzene do not exceed threshold HQ values of 1 for either no-effect-based or effect-based TRVs, nor are there any effect-based HQ values greater than one for mercury (Table E4-4). Thus, in conformity with conclusions reached during the Tier-1 and Tier-2 ERAs, these residual concentrations of hexachlorobenzene and mercury would not pose a substantive hazard to wildlife if the subject soils were to be removed to a depth of at least 5 feet bgs.

## E4.3 Development of Ecological PRGs

Residual ("post-excavation") exposure-point concentrations, background concentrations, and receptor-specific PRGs for Site 1111 were developed to aid in post-excavation confirmation sampling and ensuring compliance with risk-management targets (ecological HQs=1). The ecoPRGs for Site 1111 were derived for all the Tier-3 COPCs, even though none are predicted to pose a hazard to ecological receptors if the proposed hot-spot soil removal were to occur. The ecoPRGs are presented in Table E4-5.

**Antimony:** Several of the no-effect PRGs are below the background concentration of 8.8 mg/kg, indicating the conservatism of the assessment. The lowest of the effect-based ecoPRGs for wildlife is for the hypothetical exposures of invertivorous birds, and is a value (12 mg/kg) not much greater than the background concentration. The upper-bound limit for an acceptable exposure-point concentration (the ecoPRG) for antimony is approximately 12 mg/kg or less.

**Mercury:** Two of the no-effect PRGs are below the background concentration of 0.08 mg/kg, indicating the conservatism of the assessment. The lowest of the effect-based ecoPRGs for wildlife is for the hypothetical exposures of herbivorous mammals, and thus, the upper-bound limit for an acceptable exposure-point concentration (the ecoPRG) for mercury is approximately 8.5 mg/kg or less.

**Dioxins:** The lowest of the no-effect PRGs for wildlife is $4.4 \times 10^{-6}$ mg/kg (4.4 pg/g) for the hypothetical exposure of the deer mice population to soil-borne dioxins; the lowest of the effect-based PRGs is also for hypothetical exposure of the deer mice population, at a concentration of $4.4 \times 10^{-5}$ mg/kg (44 pg/g). The ten-fold difference in PRG values is strictly the result of the use of a ten-fold uncertainty factor applied to the same underlying toxicity data for the effect- and no-effect TRVs. The upper-bound limit for an acceptable exposure-point concentration for the dioxins (the ecoPRG) is approximately $4.4 \times 10^{-5}$ mg/kg (44 pg/g) or less.

**Hexachlorobenzene:** The lowest of the effect-based ecoPRGs for wildlife is for the hypothetical exposures of omnivorous small mammals (as represented by the deer mouse), and thus, the upper-bound limit for an acceptable exposure-point concentration (the ecoPRG) for hexachlorobenzene is approximately 0.65 mg/kg or less.

**Table E4-1**
**Site 1111 (Post-Excavation)**
**Summary of Analytical Results for Soil Samples Collected at 0 to 1.5 feet bgs**
**MCB Camp Pendleton, California**

| Analyte | Samples Analyzed | Number with Detected Analyte | Detection Frequency | Maximum Detection Limit in Non-Detect Samples (mg/kg dw) | Minimum Detected Concentration (mg/kg dw) | Average [a] (mg/kg dw) | Standard Deviation [a] (mg/kg dw) | Maximum Detected Concentration (mg/kg dw) | 95%UCL [b] |
|---|---|---|---|---|---|---|---|---|---|
| 2,3,7,8-TCDD TEQ (Bird) | 1 | 0 | 0% | 0 | None | -- | -- | None | too few samples |
| 2,3,7,8-TCDD TEQ (Mammal) | 1 | 0 | 0% | 0 | None | -- | -- | None | too few samples |
| Antimony | 27 | 3 | 11% | 0.61 | 5.9 | 0.93907 | 2.12634 | 8.4 | too few detects |
| Hexachlorobenzene | 3 | 2 | 67% | 0.000071 | 0.0001 | 0.00015 | 0.00014 | 0.0003 | too few samples |
| Mercury | 27 | 19 | 70% | 0.26 | 0.013 | 0.06321 | 0.05104 | 0.18 | 0.09 |

[a] Statistics were calculated using one-half of the reported detection limit for non-detect results (antimony, hexachlorobenzene, and mercury).
[b] The recommended value calculated using USEPA's ProUCL software (Singh *et al.*, 2004).

**Table E4-2**
**Site 1111 (Post-Excavation)**
**Summary of Aanalytical Results For Soil Samples Collected at 0 to 5 feet bgs**
**MCB Camp Pendleton, California**

| Analyte | Samples Analyzed | Number with Detected Analyte | Detection Frequency | Maximum Detection Limit in Non-Detect Samples (mg/kg dw) | Minimum Detected Concentration (mg/kg dw) | Average [a] (mg/kg dw) | Standard Deviation [a] (mg/kg dw) | Maximum Detected Concentration (mg/kg dw) | 95%UCL [b] |
|---|---|---|---|---|---|---|---|---|---|
| 2,3,7,8-TCDD TEQ (Bird) | 1 | 0 | 0% | NA | None | -- | -- | None | too few samples |
| 2,3,7,8-TCDD TEQ (Mammal) | 1 | 0 | 0% | NA | None | -- | -- | None | too few samples |
| Antimony | 66 | 5 | 8% | 0.61 | 1 | 0.55500 | 1.40323 | 8.4 | too few detects |
| Hexachlorobenzene | 6 | 3 | 50% | 0.000073 | 0.0001 | 0.00018 | 0.00023 | 0.0006 | too few samples |
| Mercury | 66 | 53 | 80% | 0.26 | 0.013 | 0.07756 | 0.14779 | 1.2 | 0.11 |

[a] Statistics were calculated using one-half of the reported detection limit for non-detect results (antimony, hexachlorobenzene, and mercury).
[b] The recommended value calculated using USEPA's ProUCL software (Singh *et al.*, 2004).

## Table E4-3
## Site 1111 (Post-Excavation)
## Summary of Tier-1 Hazard Quotients For Ecological Receptors Based on Tier-3 COPCs
## MCB Camp Pendleton, California

| Preliminary COPC [a] | Tier-1 Soil EPC (maximum) (*mg/kg soil dw*) | Background Concentration (BG) [b] (*mg/kg soil dw*) | Tier-1 HQ > 1? | | | | | | | | | | Final COPC? [c] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Mammals | | | | Birds | | | | |
| | | | Terrestrial Vegetation | Soil Invertebrates and Microbial Processes | Pacific Pocket Mouse | Deer Mouse | Southern Grasshopper Mouse | Gray Fox | California Quail | Horned Lark | Least Bell's Vireo | Red-tailed Hawk | |
| **Inorganics** | | | | | | | | | | | | | |
| Antimony | 8.4 | 8.8 | **1.68E+00** | 1.08E-01 | **8.81E+00** | **6.31E+00** | **1.40E+01** | **2.87E+00** | **5.61E+00** | **6.17E+00** | **8.08E+00** | **1.68E+00** | No |
| Mercury | 1.2 | 0.08 | **4.00E+00** | **1.20E+01** | **1.17E+01** | **8.34E+00** | **1.85E+01** | **3.80E+00** | **9.13E+00** | **1.00E+01** | **1.32E+01** | **2.73E+00** | Yes (B) |
| **Polychlorinated Dibenzo-p-dioxins and dibenzofurans** | | | | | | | | | | | | | |
| 2,3,7,8-TCDD TEQ (Bird) | Not a COPC | Not Applicable | No Exposure | No Exposure | -- | -- | -- | -- | -- | -- | -- | -- | No |
| 2,3,7,8-TCDD TEQ (Mammal) | Not a COPC | Not Applicable | No Exposure | No Exposure | -- | -- | -- | -- | -- | -- | -- | -- | No |
| **Semivolatile Organic Compounds** | | | | | | | | | | | | | |
| Hexachlorobenzene | 0.0006 | Not Applicable | No Benchmark | 6.00E-07 | 5.62E-03 | 4.02E-03 | 8.92E-03 | 1.83E-03 | 3.16E-04 | 3.48E-04 | 4.55E-04 | 9.46E-05 | Yes (B) |

[a] Tier-3 COPC evaluated in a Tier-1 assessment.
[b] Santa Margarita Basin Background (SWDIV, 1997).
[c] Preliminary COPCs are retained as final COPCs if a quantified Tier-1 HQ is greater than 1 ["Yes (HQ)"], or if the chemical is bioaccumulative ("Yes (B)"; see Table K2-4, Appendix K, Parsons, 2004a), despite any HQ values.

**Table E4-4**
**Site 1111 (Post-Excavation)**
**Summary of Tier-2 Hazard Quotients For Ecological Receptors Based on Tier-3 COPCs**
**MCB Camp Pendleton, California**

| Final COPC [1a] | Soil EPC 0- to 1.5-ft bgs (mg/kg soil dw) | Soil EPC 0- to 5-ft bgs (mg/kg soil dw) | Background Concentration (BG) [1b] (mg/kg soil dw) | Tier-1 HQ > 1? Terrestrial Vegetation | Tier-1 HQ > 1? Soil Invertebrates and Microbial Processes | Mammals: Pacific Pocket Mouse No-Effect HQ | Pacific Pocket Mouse Effect HQ | Deer Mouse No-Effect HQ | Deer Mouse Effect HQ | Southern Grasshopper Mouse No-Effect HQ | Southern Grasshopper Mouse Effect HQ | Gray Fox No-Effect HQ | Gray Fox Effect HQ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inorganics | | | | | | | | | | | | | |
| Mercury | 0.09 | 0.11 | 0.08 | Yes | No | 8.4E-01 | 8.4E-02 | 1.5E+00 | 1.5E-01 | 3.1E-01 | 3.1E-02 | 6.2E-05 | 6.2E-06 |
| Semivolatile Organic Compounds | | | | | | | | | | | | | |
| Hexachlorobenzene | 0.0003 | 0.0006 | Not Applicable | No Benchmark | No | 1.1E-04 | 2.2E-05 | 2.3E-03 | 4.6E-04 | 5.9E-04 | 1.2E-04 | 8.3E-08 | 1.7E-08 |

[1a] Final COPC (a Tier-3 COPC that failed a Tier-1 type evaluation).
[1b] Santa Margarita Basin Background (SWDIV, 1997).
[1c] COC = chemical of concern.

**Table E4-4**
**Site 1111 (Post-Excavation)**
**Summary of Tier-2 Hazard Quotients For Ecological Receptors Based on Tier-3 COPCs**
**MCB Camp Pendleton, California**

| Final COPC [a] | Soil EPC | | Background Concentration (BG) [b] | Birds | | | | | | | | Tier-3 COC [c]? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | California Quail | | Horned Lark | | Least Bell's Vireo | | Red-tailed Hawk | | |
| | 0- to 1.5-ft bgs (*mg/kg soil dw*) | 0- to 5-ft bgs (*mg/kg soil dw*) | (*mg/kg soil dw*) | No-Effect HQ | Effect HQ | No-Effect HQ | Effect HQ | No-Effect HQ | Effect HQ | No-Effect HQ | Effect HQ | |
| Inorganics | | | | | | | | | | | | |
| Mercury | 0.09 | 0.11 | 0.08 | 1.6E-02 | 3.5E-03 | 3.6E-01 | 7.8E-02 | 1.7E+00 | 3.7E-01 | 1.9E-04 | 4.1E-05 | No |
| Semivolatile Organic Compounds | | | | | | | | | | | | |
| Hexachlorobenzene | 0.0003 | 0.0006 | Not Applicable | 4.5E-07 | 1.1E-07 | 3.6E-05 | 9.1E-06 | 2.2E-04 | 5.4E-05 | 5.9E-09 | 1.5E-09 | No |

[a] Final COPC (a Tier-3 COPC that failed a Tier-1 type evaluation).
[b] Santa Margarita Basin Background (SWDIV, 1997).
[c] COC = chemical of concern.

**Table E4-5**
**Site 1111**
**Summary of Receptor-Specific Ecological Preliminary Remediation Goals**
**MCB Camp Pendleton, California**

| Tier-3 COPC [a] | Baseline Exposure-Point Concentration [b] (*mg/kg dw*) 0- to 1.5-ft bgs | 0- to 5-ft bgs | Background Concentration [c] (*mg/kg soil dw*) | Scenario-Specific [d] Soil Concentration (*mg/kg dw*) that would result in an HQ = 1: Terrestrial Vegetation No-Effect | Soil Invertebrates and Microbial Processes No-Effect | Mammals: Pacific Pocket Mouse No-Effect | Effect | Deer Mouse No-Effect | Effect | Southern Grasshopper Mouse No-Effect | Effect | Gray Fox No-Effect | Effect |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | | | | |
| Antimony | 8.4 (max) | 8.4 (max) | 8.8 | *5.0* | 78 | *5.7* | 28 | *3.3* | 16 | 16 | 80 | 50100 | 250600 |
| Mercury | 0.09 (95%UCL) | 0.11 (95%UCL) | 0.08 | 0.3 | 0.1 | 0.15 | 8.5 | *0.01* | 19 | 20 | 516 | 2640 | 26500 |
| **Polychlorinated Dibenzo-p-dioxins and dibenzofurans** | | | | | | | | | | | | | |
| 2,3,7,8-TCDD TEQ (Bird) | 7.62E-03 (max) | 7.62E-03 (max) | Not Applicable | No Benchmark | No Benchmark | -- | -- | -- | -- | -- | -- | -- | -- |
| 2,3,7,8-TCDD TEQ (Mamm | 2.85E-03 (max) | 2.85E-03 (max) | Not Applicable | No Benchmark | No Benchmark | 1.9E-04 | 1.9E-03 | 4.4E-06 | 4.4E-05 | 1.7E-05 | 1.7E-04 | 2.6E-01 | 2.6E+00 |
| **Semivolatile Organic Compounds** | | | | | | | | | | | | | |
| Hexachlorobenzene | 0.0003 (max) | 0.0006 (max) | Not Applicable | No Benchmark | 1000 | 4 | 20 | 0.13 | 0.65 | 0.51 | 2.6 | 7245 | 36220 |

[a] Tier-3 chemical of potential concern.
[b] "Post-excavation" exposure-point concentration used in a Tier-2 BERA evaluation.
[c] Santa Margarita Basin Background (SWDIV, 1997).
[d] Scenario Features:
No-Effect: Area-Use-Factor- (AUF-) adjusted exposure; no-effect TRV; and
Effect: AUF-adjusted exposure; effect-based TRV.

*Shaded italicized values* indicate a PRG less than background.

**Table E4-5**
**Site 1111**
**Summary of Receptor-Specific Ecological Preliminary Remediation Goals**
**MCB Camp Pendleton, California**

| Tier-3 COPC [a] | Baseline Exposure-Point Concentration [b] (*mg/kg dw*) 0- to 1.5-ft bgs | 0- to 5-ft bgs | Background Concentration [c] (*mg/kg soil dw*) | Scenario-Specific [d] Soil Concentration (*mg/kg dw*) that would result in an HQ = 1 — Birds: California Quail No-Effect | California Quail Effect | Horned Lark No-Effect | Horned Lark Effect | Least Bell's Vireo No-Effect | Least Bell's Vireo Effect | Red-tailed Hawk No-Effect | Red-tailed Hawk Effect |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Inorganics | | | | | | | | | | | |
| Antimony | 8.4 (max) | 8.4 (max) | 8.8 | 378 | 1135 | 18.0 | 54 | *3.9* | 12 | 40625 | 121880 |
| Mercury | 0.09 (95%UCL) | 0.11 (95%UCL) | 0.08 | 143 | 1085 | 3.6 | 62 | *0.002* | 18 | 960 | 4430 |
| Polychlorinated Dibenzo-p-dioxins and dibenzofurans | | | | | | | | | | | |
| 2,3,7,8-TCDD TEQ (Bird) | 7.62E-03 (max) | 7.62E-03 (max) | Not Applicable | 1.8E-02 | 1.8E-01 | 1.9E-04 | 1.9E-03 | 3.2E-05 | 3.2E-04 | 1.2E+00 | 1.2E+01 |
| 2,3,7,8-TCDD TEQ (Mamm | 2.85E-03 (max) | 2.85E-03 (max) | Not Applicable | -- | -- | -- | -- | -- | -- | -- | -- |
| Semivolatile Organic Compounds | | | | | | | | | | | |
| Hexachlorobenzene | 0.0003 (max) | 0.0006 (max) | Not Applicable | 732 | 2927 | 8.3 | 33 | 1.4 | 5.5 | 50830 | 203140 |

[a] Tier-3 chemical of potential concern.
[b] "Post-excavation" exposure-point concentration used in a Tier-2 BERA evaluation.
[c] Santa Margarita Basin Background (SWDIV, 1997).
[d] Scenario Features:
No-Effect: Area-Use-Factor- (AUF-) adjusted exposure; no-effect TRV; and
Effect: AUF-adjusted exposure; effect-based TRV.

*Shaded italicized values* indicate a PRG less than background.

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# APPENDIX F
# COST OF REMEDIAL ALTERNATIVES

# F INTRODUCTION

This appendix provides cost estimate information for the Feasibility Study alternatives for Site 1A-1, Site 1111, and 12 Area, Site 13 at MCB Camp Pendleton, California. The estimates were prepared following guidance of the U.S. Environmental Agency (USEPA, 2000).

This introduction includes the general methodology for developing the cost estimates and summarizes the general assumptions used in developing costs for the various options and alternatives.

Site-specific cost analysis and cost estimates are presented in:

| | | |
|---|---|---|
| • Section F1 | Site 1A-1 Soil | Tables F1-1 through F1-5 |
| • Section F2 | Site 1111 Soil | Tables F2-1 through F2-4 |
| • Section F3 | Site 1111 Groundwater | Tables F3-1 through F3-7 |
| • Section F4 | 12 Area, Site 13 Groundwater | Tables F4-1 through F4-5 |

## METHODOLOGY

Following USEPA guidance (2000), three sources of information were used to estimate costs for the detailed analysis of remedial action alternatives:

- R.S. Means Company, Inc., Environmental Restoration Assemblies Cost Book, 1997 for earthwork, backfill, and site restoration costs.
- Vendor quotations of capital and O&M costs for off-Base and on-Base soil excavation, soil transport, soil stabilization, soil disposal, groundwater treatment system equipment, carbon addition, and chemical analysis of samples.
- Past project and professional experience in similar remediation projects for estimating pumping rates and duration, number of wells, number of confirmation samples, sample shipment, the cost of excavation, and backfilling.

### Cost Estimate Components

Cost estimates include capital costs, both direct and indirect costs, and annual O&M costs. Direct costs include work plan preparation (including a Health and Safety Plan [HSP], Quality Assurance Project Plan [QAPP], Sampling and Analysis Plan [SAP], and a Long-Term Monitoring Plan, where applicable), construction costs, equipment costs, land and site development costs, and building and services costs. Indirect capital costs include engineering expenses, start-up and shakedown costs, and contingency allowances. Annual O&M costs include post-construction costs necessary to ensure the continued effectiveness of a remedial action such as operating labor costs, maintenance materials, purchased services, residue disposal, and periodic site reviews. For estimating costs of each remedial alternative, both a net present value (NPV) analyses and a non-NPV method were used. After consideration of the merits of each method, DON decided that the non-NPV method represents a more realistic estimate. This is because the costs incurred to the government to implement a given remedial alternative are paid on a year-by-year basis. The NPV method is more appropriate in situations where the full cost of remediation is paid up-front in an escrow-type of account, which earns interest over time.

### Accuracy of Cost Estimates

The accuracy of costs developed for alternatives in the FS is an important consideration. According to regulatory guidance, "study estimate" costs for the FS are expected to be accurate to plus (+) 50 to minus (–) 30 percent (USEPA, 1988). At the FS stage, the design for the remedial action is still conceptual, not detailed, and the cost estimate is considered to be 'order-of-magnitude' (USEPA, 2000d).

The cost estimates for the alternatives identified in this OU 5 FS are considered to be well within this range (i.e. more accurate than +50 to –30 percent) for the following reasons:

- Contingency factors were applied to each remedial option in accordance with recommendations provided in USEPA guidance (2000d).
- The amount of sampling data for this report is likely greater than typically used for site remediation cost estimates. In situations where uncertainty exists for a particular technology option, a range of costs is identified in the cost summary tables.

### Contingency

Where appropriate, contingency has been factored into the following cost estimates to account for unknowns, unforeseen circumstances, or unanticipated conditions that cannot be evaluated based on the currently available data (USEPA, 2000d). The use of contingencies helps reduce the risk of possible cost overruns as remedial alternatives are implemented. Two primary types of contingency are employed in an FS, which are scope and bid contingency. Scope contingency addresses uncertainties due to scope changes that might occur during design due to limited experience with certain remedial technologies, potential changes in regulatory requirements or policy, or inaccuracies in estimated quantities or characteristics. Bid contingency represent costs that cannot be foreseen at the time of the FS preparation, which are likely to become known or better understood as remedial construction or operation and maintenance progresses. It acknowledges the potential for changes in costs that occur after contracts are awarded, and typically represents a reserve for overruns, modifications, change orders, etc. For the purpose of this FS, bid and scope contingencies are reflected as a combined percentage, specified as a line item in the following cost estimate tables and applied to total construction and/or O&M costs, as appropriate.

## GENERAL ASSUMPTIONS

Certain major assumptions were made to provide a basis for estimating the cost of various elements and components of alternatives. Assumptions that impact the cost estimates for several of the options and alternatives are identified in this section and those that apply to specific options and alternatives are identified in the site-specific sections.

### Excluded Costs

- Insurance, licensing, and taxes.

**Capital Costs**

- Prices for process equipment, treatment systems, and treatability studies are based on vendor quotes and on previous experience.
- Well installation costs are based on previous experience.
- Engineering and construction oversight costs are either variable percentages of capital costs or lump sum costs and are based on previous experience.
- Investigation-derived waste (IDW) disposal assumes non-hazardous wastes.
- Capital costs include the preparation of a work plan, a HSP, SAP, QAPP, and Long-Term Monitoring Plan where appropriate.

**Operation and Maintenance Costs**

- Labor cost includes costs for operational sampling, operation, and general maintenance.
- Health and safety costs are factored into the labor estimates and assumed Level D personal protection equipment (PPE) at temperatures less than 85°F.
- Analytical costs are based on vendor laboratory costs.

**Periodic Costs**

- Alternatives would be reevaluated for effectiveness every 5 years.
- Periodic costs include updates to institutional controls plans, evaluation of well monitoring frequencies, evaluation of system performance, confirmation monitoring, well abandonment, demobilization of treatment equipment, and site closure reports.

**Groundwater Monitoring Costs**

- Well installation costs are based on previous work experience.
- A 20 percent increase for VOC analysis will be included for QA/QC samples.
- Three wells will be sampled per an 8-hour day with a two-person crew.
- Low flow purging and sampling is assumed in estimating wastewater disposal.
- Purge water from 3.5 wells will fill a 55-gallon drum.

# APPENDIX F1
# COST ESTIMATES FOR THE SITE 1A-1 SOIL ALTERNATIVES

# F1 COST ESTIMATES FOR THE SITE 1A-1 SOIL ALTERNATIVES

This section provides the cost estimates for the remedial action alternatives for Site 1A-1 that are described in Section 2 of the main document. A summary of the total cost for each of the Site 1A-1 alternatives is presented in Table F1-1.

As a necessary precursor to estimating costs for Site 1A-1, the FS investigation evaluated soil potentially requiring remediation from the standpoint of waste type (classification) and volume (lateral and vertical extent). Based on the concentrations of soil that exceeded the remedial goals (RGs), the soil was preliminarily classified as RCRA-hazardous, California-hazardous, or non-hazardous waste. The waste classifications would only apply upon generation of a solid waste following excavation of the material (i.e., the material would not classify as a "waste" if left in situ). As such, the waste classifications are potentially relevant to soil excavated during site remediation.

Preliminary waste classification assumptions are provided on the cost tables.

The estimated volume of soil exceeding RGs at Site 1A-1 was approximately 20,000 cubic yards. Of the impacted material, approximately 45 percent of the total was above the RCRA-hazardous criteria.

Using the estimated volumes and preliminary classifications (where appropriate), the cost estimates for the site-specific remedial alternatives were developed as discussed below:

## F1.1 Alternative 1A1-1: No Action

This alternative involves no additional actions to mitigate current site conditions and thus, has no cost associated with it.

## F1.2 Alternative 1A1-2: Institutional Controls

Alternative 1A1-2 involves implementation of land use restrictions and monitoring the site for erosion.

The following are alternative-specific assumptions for Alternative 1A1-2:

- Capital cost includes a lump sum for administrative measures required for implementation of land use controls (estimated to be $75,000).
- Annual O&M costs include site monitoring for erosion control and continued compliance with land use restrictions.

If institutional controls were implemented, there would be indirect costs associated with the Base not being able to use the property without restrictions for training and other purposes. This potential loss of land use is not quantified in this document, but is considered as a factor in evaluating implementability of institutional controls as a remedial alternative.

In summary, the estimated net total cost of the alternative, which includes capital and O&M costs, is $295,000.

## F1.3 Alternative 1A1-3: Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls

Alternative 1A1-3 involves the installation and maintenance of a cap and institutional controls. Estimated costs are presented in Table F1-3 and the underlying assumptions are summarized below:

Capital Costs:

- Construction, including mobilization/demobilization, would be completed in 13 weeks.
- A survey would be conducted after mobilization, completion of foundation grading, completion of geotextile filter, and final grade.
- Erosion control setup for mobilization/demobilization and no further adjustments.
- Dust suppression/control for two full site passes per day.
- Temporary roads connect to nearest roadway only.
- Air Monitoring. Samples would be collected for five consecutive days during foundation grading. Four area air samples and three personal air samples would be collected each day of sampling.
- Area of the cap and geogrid equals area of waste fill soil and surface debris (approximately 66,700 square feet), then increased by 30% to allow for cap overlap to eliminate infiltration and to strengthen cap integrity.
- Cap design - unstable/landfill approximation with uneven settlement.
- Cap design - soil cap with 95 percent compaction, evaporation/evapotranspiration, and grades less than 5 percent to inhibit water infiltration at 2 ft. below ground surface.
- Cap storm water drainage would include earthen swales incorporated in the design/installation of the cap grade and perimeter drainage.
- Clean topsoil is locally available at $8.00 or less per cubic yard.
- Rounded cobbles are locally available at $17.00 or less per cubic yard.
- Vegetative cover would emulate local short rooted plants; would not include shrubs or trees.
- Fresh water source (drinking water, reclaim water, lake, etc.) is locally available within 1,000 feet of site.
- Cap has a 50-year life expectancy.

O&M Costs:

- Engineering, administration, professional labor as indicated.
- Area watering is every two weeks and 9 months/yr.
- Period of monitoring and cap maintenance is 50 years.
- Annually replace 2 inches of topsoil.

In summary, the estimated total cost for Alternative 1A1-3 is $2,575,000. Because the costs would be incurred over a long time frame (a 50-year life expectancy), O&M costs were estimated to be $1,565,000

## F1.4 Alternative 1A1-4: Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal

Alternative 4 involves the excavation and off-Base disposal of impacted soil. Estimated costs are presented in Tables F1-4 and F1-5 and the underlying assumptions are summarized below:

- Access to site is granted without restriction.
- Approximately 20,000 cubic yards of material would require excavation (approximately 1.5 acres multiplied by the average depth of contamination, estimated at about 8 feet).
- Approximate conversion factor from in-situ cubic yards to ex-situ cubic yards equals 1.3.
- Approximate conversion factor from cubic yards to tons equals 1.5.
- All RCRA- and California-hazardous materials would be mixed with a reagent for chemical stabilization at the site.
- Excavated soil would be temporarily staged and treated on site, tentatively in the flat-lying, approximately 300- by 600-foot unpaved area immediately west of and adjacent to the excavation.
- The staging and treatment area would have ready vehicle access.
- Temporary fencing, barricades, and other site security measures are included in project other direct costs (ODCs).
- Analytical parameters are specified in the site-specific cost table. Costs were based on standard two-week turnaround times.
- A nearby (within 10 miles) borrow source for clean, imported fill was assumed.
- Confirmation samples would be collected from chemically stabilized stockpiles to determine ultimate disposition of soil.
- Confirmation stockpile samples would be collected at a rate of one per every 500 tons of soil.
- Confirmation stockpile samples would be analyzed for soluble lead (STLC/TCLP).
- Materials with total lead concentrations less than 350 mg/kg before treatment and STLC concentrations less than 5.0 mg/L after treatment would be disposed of at the Waste Management Bradley facility as non-hazardous.
- Materials that have total lead concentrations greater than 350 mg/kg or STLC concentrations greater than 5.0 mg/L and TCLP concentrations less than 5.0 mg/L after treatment would be disposed of at the Waste Management Kettleman Hills facility as California-hazardous.

- Materials with TCLP concentrations greater than 5.0 mg/L would be stabilized and disposed of at the Waste Management Kettleman Hills facility as RCRA-hazardous.
- Portable scales would be used on site to weigh trucks so that trucks leaving the Base would not need to be weighed using the Base scales.
- Air samples would be collected daily for the duration of the project. Four area air samples and three personal air samples would be collected each day of sampling.
- Manifests would be signed by a designated Base representative.
- Approximately 600 tons of material would be removed from the site daily.
- Personnel working in the stabilization processing area would wear air-purifying respirators, chemically resistant gloves, and Tyvek for personal protective equipment.
- Work stoppages associated with Base restrictions have not been included in this cost estimate.
- One confirmation sample would be collected below the excavated areas representing 1,600 square feet (40-foot by 40-foot grid) to confirm the effectiveness of this remedial alternative.
- Excavation of contaminated material would be initiated prior to mobilization of treatment equipment.
- Work would be performed during the day on 5-day/8-hour work shifts. No costs for overtime hours or off hours work has been included in this cost estimate.
- Workers would be paid at prevailing wage rates.

In summary, the estimated total cost for Alternative 1A1-4 is $8,062,600. Because the costs would be incurred over a relatively short time frame (i.e., less than one year), O&M is not anticipated.

## Table F1-1
## Site 1A-1
## Summary of Total Cost of Alternatives

| Alternative | Description | O&M Cost ($) | Capital Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| 1 | No Action | 0 | 0 | 0 |
| 2 | Institutional Controls | 220,000 | 75,000 | 295,000 |
| 3 | Capping (Engineered Soil Cover), Cap Monitoring/Maintenance and Institutional Controls | 1,565,000 | 1,010,000 | 2,575,000 |
| 4 | Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal | 0 | 8,062,600 | 8,062,600 |

# Table F1-2
# Site 1A-1
# Alternative 1A-2: Institutional Controls
# Cumulative Cost Estimate

| Year | Annual O&M[a] ($) | Capital[b] ($) | Cumulative Cost ($) |
|---|---|---|---|
| 0 | 0 | 75,000 | 75,000 |
| 1 | 5,000 | 0 | 80,000 |
| 2 | 5,000 | 0 | 85,000 |
| 3 | 5,000 | 0 | 90,000 |
| 4 | 15,000 | 0 | 105,000 |
| 5 | 5,000 | 0 | 110,000 |
| 6 | 5,000 | 0 | 115,000 |
| 7 | 5,000 | 0 | 120,000 |
| 8 | 15,000 | 0 | 135,000 |
| 9 | 5,000 | 0 | 140,000 |
| 10 | 5,000 | 0 | 145,000 |
| 11 | 5,000 | 0 | 150,000 |
| 12 | 15,000 | 0 | 165,000 |
| 13 | 5,000 | 0 | 170,000 |
| 14 | 5,000 | 0 | 175,000 |
| 15 | 5,000 | 0 | 180,000 |
| 16 | 15,000 | 0 | 195,000 |
| 17 | 5,000 | 0 | 200,000 |
| 18 | 5,000 | 0 | 205,000 |
| 19 | 5,000 | 0 | 210,000 |
| 20 | 15,000 | 0 | 225,000 |
| 21 | 5,000 | 0 | 230,000 |
| 22 | 5,000 | 0 | 235,000 |
| 23 | 5,000 | 0 | 240,000 |
| 24 | 15,000 | 0 | 255,000 |
| 25 | 5,000 | 0 | 260,000 |
| 26 | 5,000 | 0 | 265,000 |
| 27 | 5,000 | 0 | 270,000 |
| 28 | 15,000 | 0 | 285,000 |
| 29 | 5,000 | 0 | 290,000 |
| 30 | 5,000 | 0 | 295,000 |
| **TOTAL FOR ALTERNATIVE 2** | | | **295,000** |

[a]Annual O&M costs include site monitoring for erosion, land use, and ecological impact, and quadrennial surveys.

[b]Capital cost includes a lump sum cost for administrative measures for implementation of land use controls (estimated to be $75,000).

Tab -3
Site 1A-1
Alternative 1A-3: Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls
Estimated Total Costs

| TASK DESCRIPTION AND SUPPORTING DETAILS | MATERIAL | | | | | LABOR | | | SUBTOTAL | Total Subcontractor Costs |
|---|---|---|---|---|---|---|---|---|---|---|
| | Units | No. of Units | Cost or Mat'l Rate | Mtl/Hr | Material Cost | Rate | Hours | Cost | | |
| **Task 1 - Design and Management** | | | | | | | | | | $ 240,000 |
| **Engineering, Design, and Permitting** | **Lot** | **17%** | **2%** | | **$ 2,003** | **$ 589,000** | | **$ 100,130** | **$ 102,100** | |
| **Administration, Meetings, and Inspection** | **Lot** | **5%** | **2%** | | **$ 589** | **$ 589,000** | | **$ 29,450** | **$ 30,000** | |
| **Professional (Supervisory) Labor** | **Lot** | **3%** | **2%** | | **$ 353** | **$ 589,000** | | **$ 17,670** | **$ 18,000** | |
| **Construction Management** | **Lot** | **12%** | **2%** | | **$ 1,414** | **$ 589,000** | | **$ 70,680** | **$ 72,100** | |
| **Construction - Home Office & Technical Support** | **Lot** | **3%** | **2%** | | **$ 353** | **$ 589,000** | | **$ 17,670** | **$ 18,000** | |
| | | | | | | | | | | |
| **Task 2 - Site Preparation, Site Support, and Temporary Facilities** | | | | | | | | | | |
| **Mobilization/Temporary Facilities** | | | | | **$ 23,493** | | | | **$ 23,493** | |
| Skip loaders / backhoes | Each | 2 | $ 650 | | $ 1,300 | | | | $ 1,300 | |
| Dozer 105HP D5 | Each | i | $ 650 | | $ 650 | | | | $ 650 | |
| Scraper, Std, 15 CY - 621 | Each | 2 | $ 650 | | $ 1,300 | | | | $ 1,300 | |
| Dump Truck, 10CY | Each | i | $ 500 | | $ 500 | | | | $ 500 | |
| Bobcat Front End Loader | Each | i | $ 400 | | $ 400 | | | | $ 400 | |
| Water Truck | Each | i | $ 500 | | $ 500 | | | | $ 500 | |
| Pickup Trucks | Each | 2 | $ 250 | | $ 500 | | | | $ 500 | |
| Temporary Fencing | LF | 1150 | $ 15.95 | | $ 18,343 | Included with Material Rate | | | $ 18,343 | |
| **Survey** | | | | | **$ 316** | **$ 55.00** | **120** | **$ 6,600** | **$ 6,916** | |
| **Dust and Erosion Control** | | | | | **$ 1,600** | **$ 44.50** | **182** | **$ 8,099** | $ 9,699 | |
| **Clearing and Grubbing** | **ACRE** | **2.56** | | **70** | **$ -** | **$ 112.00** | **179** | **$ 20,103** | **$ 20,103** | |
| **Grubbing Disposal** | **CY** | **2100** | **5.00** | **0.21** | **$ 10,500** | **$ 100.00** | **441** | **$ 44,100** | **$ 54,600** | |
| **On-Call Labor** | | | | | | | | | **$ 23,400** | |
| Dust Suppression | Wks | 13 | | 20.00 | $ - | $ 60.00 | 260 | $ 15,600 | $ 15,600 | |
| General Site Labor, stormwater, maintenance, etc. | Lot | i | | | | $ 60.00 | 130 | $ 7,800 | $ 7,800 | |
| **Temporary Roads** | | | | | | | | | **$ 7,433** | |
| Roads | Lot | i | 2000.00 | | $ 2,000 | $ 90.00 | 40 | $ 3,600 | $ 5,600 | |
| Gravel Overlay | CY | 22 | 15.80 | 0.75 | $ 348 | $ 90.00 | 17 | $ 1,485 | $ 1,833 | |
| **Temporary Field Facilities & Expenses** | **Lot** | **1** | **50000** | | **$ 50,000** | | | **$ -** | **$ 50,000** | |
| | | | | | | | | | | |
| **Task 3 - Cap Installation** | | | | | | | | | | $ 391,000 |
| **Foundation Grade** | | | | | | | | | **$ 95,120** | |
| Scraper, Std, 15 CY - 621 w/D5 Dozer (11 Work Days) | CY | 4,100 | | 0.16 | $ - | $ 90 | 656 | $ 59,040 | $ 59,040 | |
| Compaction w/ Smooth Vibratory Roller (assumes first 6" lift compacted only) | CY | 2,068 | | 1.48 | $ - | $ 55 | 656 | $ 36,080 | $ 36,080 | |
| **Air Monitoring (personnel monitoring for air-borne heavy metals)** | **Sample** | **15** | **900** | **4** | **$ 13,500** | **$ 75** | **60** | **$ 4,500** | **$ 18,000** | |
| **Cobbles and Geogrid Layer** | | | | | | | **-** | **$ -** | **$ 247,854** | |
| Sand, Uniform Grain Size, 6" Layer (14 Work Days) | CY | 2,070 | 15.50 | 0.4 | $ 32,085 | $ 52.50 | 828 | $ 43,470 | $ 75,555 | |
| Geogrid Installation in Sand Layer (Tensar BX1200 Biaxial) | SF | 111,700 | 0.39 | 0.0039 | $ 43,563 | $ 60.00 | 436 | $ 26,138 | $ 69,701 | |
| Rounded Cobbles in Mechanical Barrier, 1-ft. Layer (5 Work Days) | CY | 4,137 | 17.00 | 0.065 | $ 70,330 | $ 120.00 | 269 | $ 32,269 | $ 102,599 | |
| **GeoTextile Cushion (5 Days) - (1120N 11.4 oz)** | **SF** | **111,700** | **0.14** | **0.0026** | **$ 15,638** | **$ 50.00** | **290** | **$ 14,521** | **$ 30,159** | |
| **Quality Assurance / Quality Control Contractor** | | | | | | | | | **$ 70,350** | |
| Project Manager, 1, Hourly | Days | 67 | | 8 | $ - | $ 65 | 536 | $ 34,840 | $ 34,840 | |
| Technician, i, Hourly | Days | 67 | 130 | 8 | $ 8,710 | $ 50 | 536 | $ 26,800 | $ 35,510 | |
| | | | | | | | | | | |
| **Task 4 - Overall Site Grading** | | | | | | | | | | $ 101,000 |
| **Top Cover** | | | | | | | | | **$ 79,928** | |
| Topsoil, 6" Lifts, Off-site borrow | CY | 8,274 | 8.00 | 0.016 | $ 65,365 | $ 55 | 132 | $ 7,281 | $ 72,646 | |
| Compaction w/ Smooth Vibratory Roller | CY | 8,274 | | 1.48 | $ - | $ 55 | 132 | $ 7,281 | $ 7,281 | |
| **Quality Assurance / Quality Control Contractor** | | | | | | | | | **$ 21,000** | |
| Project Manager, i, Hourly | Days | 20 | | 8 | $ - | $ 65 | 160 | $ 10,400 | $ 10,400 | |
| Technician, i, Hourly | Days | 20 | 130 | 8 | $ 2,600 | $ 50 | 160 | $ 8,000 | $ 10,600 | |

# Table F1-3
## Site 1A-1
## Alternative 1A-3: Capping (Engineered Soil Cover), Cap Monitoring/Maintenance, and Institutional Controls
## Estimated Total Costs

| TASK DESCRIPTION AND SUPPORTING DETAILS | MATERIAL | | | | | LABOR | | | SUBTOTAL | Total Subcontractor Costs |
|---|---|---|---|---|---|---|---|---|---|---|
| | Units | No. of Units | Cost or Mat'l Rate | Mtl/Hr | Material Cost | Rate | Hours | Cost | | |
| **Task 5 - Landscaping and Temporary Irrigation** | | | | | | | | | | $ 25,000 |
| Seeding, Natural Vegetative Cover (3 days) | ACRE | 2.56 | 2,130 | | $ 5,462 | | | $ - | $ 5,462 | |
| Temporary Irrigation, Mobilization and Demobilization (4 days) | ACRE | 2.56 | 7,500 | | $ 19,231 | | | $ - | $ 19,231 | |
| **Task 6 - Certification Report** | | | | | | | | | | $ 25,000 |
| QA/QC Input | 1 | Lot | | | | | | $ 25,000 | $ 25,000 | |
| Contingency (20%=10%[Bid]+10%[Scope]) | | | | | | | | | | $ 156,400 |
| Institutional Controls | | | | | | | | | | $ 75,000 |
| **ESTIMATED TOTAL CAPITAL** | | | | | | | | | | $ 1,010,000 |
| **OPERATION AND MAINTENANCE** | | | | | | | | | | |
| **Task 7 - Annual Operation and Maintenance** | | | | | | | | | | $ 26,100 |
| Monitoring | | | | | | | | | $ 7,390 | |
| Before, During, and After Rainfall Season (3 times annually) | Lot | 3 | 100 | | $ 300 | $ 120 | 24 | $ 2,880 | $ 3,180 | |
| Survey | Lot | 1 | 100 | | $ 100 | $ 150 | 8 | $ 1,200 | $ 1,300 | |
| Checklist Report | Lot | 3 | 10 | | $ 30 | $ 120 | 24 | $ 2,880 | $ 2,910 | |
| Routine Maintenance | | | | | | | | | $ 13,855 | |
| Topsoil, 6-inch lifts, Off-site (2-inch layer per year due to loss) | CY | 690 | 8.00 | 0.016 | $ 5,447 | $ 55 | 11 | $ 607 | $ 6,054 | |
| Weeding/Seeding, Vegetative Cover (once/year) | ACRE | 2.56 | 1436.07 | | $ 3,682 | $ - | | $ - | $ 3,682 | |
| Fertilize, 800-lb/Acre, Push Rotary (once/year) | ACRE | 2.56 | 125.00 | | $ 321 | $ - | | $ - | $ 321 | |
| Watering w/ 3,000-Gal Tank Truck, Per Pass (Every 2 wks, 9 months/yea | ACRE | 28.5 | 133.28 | | $ 3,798 | $ - | | $ - | $ 3,798 | |
| Annual Data Review and Reporting, Administration | Lot | 1 | 100 | | $ 100 | $ 120 | 40 | $ 4,800 | $ 4,900 | |
| Contingency (20%=10%[Bid]+10%[Scope]) | | | | | | | | | | $ 5,200 |
| **ESTIMATED ANNUAL OPERATION AND MAINTENANCE** | | | | | | | | | | $ 31,300 |

**TOTAL COST BASED ON 50-YEAR LIFE EXPECTANCY** $ 2,575,000

| | |
|---|---|
| Capital | $ 1,010,000 |
| Operation & Maintenance | $ 1,565,000 |

**ASSUMPTIONS**

**Capital Costs**

Construction, including mob/demob will be completed in 13 calendar weeks.
Survey will be conducted after mobilization, completion of foundation grading, completion of geotextile filter, and final grade.
Erosion control setup for mob/demob and no further adjustments
Dust suppression/control for 2 full site passes per day.
Temporary Roads connect to nearest roadway only.
Air Monitoring. Samples will be collected for five consecutive days during foundation grading. Four area air samples and three personal air samples will be collected each day of sampling.
Area of the cap and geogrid equals area of waste fill soil and surface debris (approximately 66,700 square feet), then increased by 30% to allow for cap overlap to eliminate infiltration and to strengthen cap integrity.
Cap design - unstable/landfill approximation with uneven settlement.
Cap design - soil cap with 95% compaction, evaporation/evapotranspiration, and grades > 5% to inhibit water infiltration at 2-ft. below ground surface.
Cap stormwater drainage will include earthened swales incorporated in the the design/installation of the cap grade and perimeter drainage.
Clean top soil is locally available at $8.00 or less per cubic yard.
Rounded cobbles are locally available at $17.00 or less per cubic yard.
Vegetative cover will emulate local short rooted plants; will not include shrubs or trees.
Fresh water source (drinking water, reclaim water, lake, etc.) is locally available within 1,000 feet of site.
50-year life expectancy

**O&M Costs**

Engineering, Administration, Prof Labor as indicated
Area watering is every two weeks and 9 months/yr
Period of monitoring and cap maintenance
Annually replace 2 in. of top soil

**Table F1-4**
**Site 1A-1**
**Excavation, Soil Pre-treatment, Backfill, and off-Base Disposal**
**Total Estimated Costs**

| Professional Category | Sr. Tech. Dir. | Proj. Mgr. | Sup. Engineer | Sr. Engineer | Engineer | Sup. Scientist | Sr. Scientist | Scientist | Sup. Specialist | Sr. Spec. I | Total Hours | Total Labor $ | Total ODCs $ | Subtotal Cost | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard Billing Rate ($/hr) | $126.07 | $114.39 | $115.40 | $86.98 | $65.95 | $109.09 | $69.62 | $53.41 | $73.90 | $42.57 | | | | | |
| **Task 1 - Planning, Direction, Oversight, Scheduling, Meetings, and Scope Preparation** | | | | | | | | | | | | | | | |
| Planning | 20 | 100 | 50 | 0 | 0 | 50 | 0 | 0 | 100 | 100 | 420 | $ 36,831.90 | $ - | $ 36,831.90 | |
| Direction and Oversight | 20 | 40 | 20 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 100 | $ 11,586.80 | $ - | $ 11,586.80 | |
| Schedule Preparation and Implementation | 20 | 40 | 20 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 100 | $ 11,586.80 | $ - | $ 11,586.80 | |
| Meetings | 20 | 40 | 20 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 100 | $ 11,586.80 | $ - | $ 11,586.80 | |
| Scope Preparation | 20 | 40 | 20 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 100 | $ 11,586.80 | $ - | $ 11,586.80 | |
| ODCs - Subcontractors | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 15,000.00 | $ 15,000.00 | |
| **Total Cost for Task 1** | | | | | | | | | | | | | | | $ 98,179.10 |
| **Task 2 - Mobilization** | | | | | | | | | | | | | | | |
| Mobilization | 8 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 20 | 20 | 328 | $ 27,931.56 | $ - | $ 27,931.56 | |
| ODC - Subcontractor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 100,000.00 | $ 100,000.00 | |
| **Total Cost for Task 2** | | | | | | | | | | | | | | | $ 127,931.56 |
| **Task 3 - Excavation/Stockpiling of Impacted Soil** | | | | | | | | | | | | | | | |
| Excavation Oversight | 20 | 156 | 312 | 0 | 312 | 312 | 0 | 312 | 20 | 20 | 1464 | $ 129,976.84 | $ - | $ 129,976.84 | |
| Soil Stockpile Confirmation Sampling | 0 | 0 | 0 | 156 | 0 | 0 | 156 | 0 | 0 | 0 | 312 | $ 24,429.60 | $ - | $ 24,429.60 | |
| Air Monitoring | 0 | 0 | 0 | 156 | 0 | 0 | 156 | 0 | 0 | 0 | 312 | $ 24,429.60 | $ - | $ 24,429.60 | |
| ODC - Subcontractor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 726,999.00 | $ 726,999.00 | |
| **Total Cost for Task 3** | | | | | | | | | | | | | | | $ 905,835.04 |
| **Task 4 - Soil Pretreatment** | | | | | | | | | | | | | | | |
| Pretreatment Oversight | 20 | 156 | 0 | 312 | 0 | 0 | 312 | 0 | 20 | 20 | 840 | $ 71,554.84 | $ - | $ 71,554.84 | |
| ODC - Subcontractor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 757,107.00 | $ 757,107.00 | |
| **Total Cost for Task 4** | | | | | | | | | | | | | | | $ 828,661.84 |
| **Task 5 - Transport and Disposal of Soil** | | | | | | | | | | | | | | | |
| Manifest Tracking and Oversight | 20 | 40 | 40 | 0 | 312 | 40 | 0 | 312 | 20 | 20 | 804 | $ 55,646.32 | $ - | $ 55,646.32 | |
| ODC - Subcontractor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 3,198,000.00 | $ 3,198,000.00 | |
| **Total Cost for Task 5** | | | | | | | | | | | | | | | $ 3,253,646.32 |
| **Task 6 - In-Situ Confirmation Sampling** | | | | | | | | | | | | | | | |
| Sample Collection | 5 | 10 | 10 | 20 | 40 | 10 | 20 | 40 | 20 | 20 | 195 | $ 14,254.95 | $ - | $ 14,254.95 | |
| ODC-Subcontractor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 51,660.00 | $ 51,660.00 | |
| **Total Cost for Task 6** | | | | | | | | | | | | | | | $ 65,914.95 |
| **Task 7 - Backfill and Compaction** | | | | | | | | | | | | | | | |
| Backfill/Compaction Oversight | 10 | 20 | 40 | 156 | 156 | 0 | 0 | 0 | 20 | 20 | 422 | $ 34,350.98 | $ - | $ 34,350.98 | |
| ODC - Subcontractor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 990,996.95 | $ 990,996.95 | |
| **Total Cost for Task 7** | | | | | | | | | | | | | | | $ 1,025,347.93 |
| **Task 8 - Reporting** | | | | | | | | | | | | | | | |
| Draft Report Preparation | 10 | 80 | 40 | 100 | 200 | 40 | 100 | 200 | 40 | 40 | 850 | $ 63,582.30 | $ - | $ 63,582.30 | |
| Incorporate Comments from MCB and Regulators | 4 | 20 | 10 | 25 | 40 | 10 | 25 | 40 | 10 | 10 | 194 | $ 14,891.08 | $ - | $ 14,891.08 | |
| Finalize Report | 4 | 20 | 10 | 25 | 40 | 10 | 25 | 40 | 10 | 10 | 194 | $ 14,891.08 | $ - | $ 14,891.08 | |
| **Total Cost for Task 8** | | | | | | | | | | | | | | | $ 93,364.46 |
| **Other Direct Costs - Parsons (5% of Project Total)** | | | | | | | | | | | | | $ 319,944.06 | $ 319,944.06 | $ 319,944.06 |
| **Contingency (20%=10%[Bid]+10%[Scope])** | | | | | | | | | | | | | | | $ 1,343,765.05 |
| **Total** | **201** | **802** | **632** | **990** | **1140** | **592** | **834** | **984** | **280** | **280** | **6735** | **$ 559,118.25** | **$ 6,159,707.01** | | **$ 8,062,590.31** |

**ASSUMPTIONS:**

Access to site is granted without restriction
Excavation for treatment will be initiated prior to transport and disposal operations
Conversion factor from in-situ cubic yards to ex-situ cubic yards (fluff) = 1.3
Conversion factor from cubic yards to tons = 1.5
Confirmation samples will be collected from stockpiles to determine ultimate disposition of soil (1 per 500 tons)
Confirmation stockpile samples will be analyzed for total metals, soluble metals, soluble dioxins and soluble pesticides (STLC/TCLP)
Materials with total concentrations <10 X the STLC will be deposited at Waste Management Bradley Facility as Non-Haz
Materials with total concentrations >10 X the STLC will be analyzed using a Waste Extraction Test (WET). Results from the WET will be compared to the STLC value for the individual constituent. If WET results exceed the STLC a Toxicity Characteristic Leaching Potential (TCLP) test will be performed.
Materials with WET concentrations greater than the STLC but less than the TCLP will be deposited in the Waste Management Kettleman Hills Facility as CA-Haz
Materials with concentrations greater than the TCLP will be treated on-site stabilized transported and disposed in the Waste Management Kettleman Hills Facility as CA-Haz
Portable scales will be used on-site to weigh trucks so that trucks leaving the Base will not need to be weighed using the Base scales
Air samples will be collected on a daily basis for the duration of the project Four area air samples and three personal air samples will be collected each day of sampling
Manifests will be signed by a designated Base representative
Approximately 1 000 tons of material will be removed from the Site on a daily basis
Work stoppages associated with Base restrictions have not been included in this cost estimate
Confirmation samples will be collected which will be representative of approximately 1600 square feet (40'X40') to confirm the effectiveness of this remedial alternative
Work will be performed during the day on 5-day/8-hour work shifts No costs for overtime hours or off hours work has been included in this cost estimate
Workers will be paid at prevailing wage rates
45% of Material removed will require treatment from RCRA Hazardous levels to CA Hazardous levels
90% of Material transported and disposed will be CA Hazardous
10% of Material removed will be Non-hazardous

**Table F1-5**
**Site 1A-1**
**Excavation, Soil Pre-treatment, Backfill, and off-Base Disposal**
**Detailed Subcontractor Costs Costs**

| Description of Subcontractor Costs<br>Standard Billing Rate ($/hr) | Unit Rate | Units | Subtotal | Total Subcontractor Costs |
|---|---|---|---|---|
| **Task 1 - Planning, Direction, Oversight, Scheduling, Meetings, and Scope Preparation** | | | | |
| Subcontractor (WMI) | $ 5,000.00 | 1 | $ 5,000.00 | |
| Subcontractor (NRC Env) | $ 5,000.00 | 1 | $ 5,000.00 | |
| Subcontractor (CalScience) | $ 5,000.00 | 1 | $ 5,000.00 | |
| **Subtotal for Subcontractors - Task 1** | | | | **$ 15,000.00** |
| | | | | |
| **Task 2 - Mobilization (Lump Sum)** | | | | |
| Subcontractor (WMI) | $ 50,000.00 | 1 | $ 50,000.00 | |
| Subcontractor (NRC Env) | $ 50,000.00 | 1 | $ 50,000.00 | |
| **Subtotal for Subcontractors - Task 2** | | | | **$ 100,000.00** |
| | | | | |
| **Task 3 - Excavation/Stockpiling/Loading of Impacted Soil** | | | | |
| Subcontractor (NRC Env) 39 Working Days @ 8 Hours/day for Excavation of Material | | | | |
| Project Manager (0.5) Hourly | $ 115.00 | 156 | $ 17,940.00 | |
| Project Superintendent (1) Hourly | $ 97.75 | 312 | $ 30,498.00 | |
| Operator (3) Hourly | $ 72.45 | 936 | $ 67,813.20 | |
| Driver (2) Hourly | $ 72.45 | 624 | $ 45,208.80 | |
| Laborer (4) Hourly | $ 51.75 | 1248 | $ 64,584.00 | |
| CAT 235 Trackhoe (1) Daily including fuel | $ 1,115.50 | 39 | $ 43,504.50 | |
| CAT 950 Loader (1) Daily including fuel | $ 632.50 | 39 | $ 24,667.50 | |
| CAT 920 Loader (1) Daily including fuel | $ 632.50 | 39 | $ 24,667.50 | |
| Read RD90B Screening Plant (1) Daily including fuel | $ 1,265.00 | 39 | $ 49,335.00 | |
| Water Trucks, 4,000 Gallon (2) Daily including fuel | $ 603.75 | 78 | $ 47,092.50 | |
| NRC Env Other Direct Costs | $ 250.00 | 39 | $ 9,750.00 | |
| Subcontractor (CalScience) Stockpile Samples | | | | |
| Title 22 Metals (EPA Method 6010/7000) 24-hour TAT | $ 230.00 | 78 | $ 17,940.00 | |
| Pesticides/Herbicides (EPA Method 8080) 24 hour TAT | $ 300.00 | 78 | $ 23,400.00 | |
| STLC (Waste Extraction Test & Analysis) 24-hour TAT | $ 92.00 | 78 | $ 7,176.00 | |
| TCLP (TCLP Extraction and Analysis) 24-hour TAT | $ 92.00 | 78 | $ 7,176.00 | |
| Subcontractor (EMS) Air Monitoring Samples | | | | |
| Metals Analysis (except hex chromium) 24 hour TAT | $ 92.00 | 273 | $ 25,116.00 | |
| Metals Analysis (hex chromium) 24 hour TAT | $ 92.00 | 273 | $ 25,116.00 | |
| Total Dust 24 hour TAT | $ 30.00 | 273 | $ 8,190.00 | |
| Respirable Dust 24 hour TAT | $ 30.00 | 273 | $ 8,190.00 | |
| Total Silica (includes crocidolite and trydimite) 24 hour TAT | $ 329.00 | 273 | $ 89,817.00 | |
| Respirable Silica (includes crocidolite and trydimite) 24 hour TAT | $ 329.00 | 273 | $ 89,817.00 | |
| **Subtotal for Subcontractors - Task 3** | | | | **$ 726,999.00** |
| | | | | |
| **Task 4 - Soil Pretreatment** | | | | |
| Subcontractor (WMI) | | | | |
| Process 17,550 tons of Material | $ 43.14 | 17550 | $ 757,107.00 | |
| **Subtotal for Subcontractors - Task 4** | | | | **$ 757,107.00** |
| | | | | |
| **Task 5 - Transport and Disposal of Soil** | | | | |
| Subcontractor (WMI) | | | | |
| Transport and Disposal of CA Hazardous Material to WMI Kettleman Hills Facility (tons of contaminated soil) | $ 85.00 | 35100 | $ 2,983,500.00 | |
| Transport and Disposal of Non-Hazardous Material to WMI Bradley Facility (tons of contaminated soil) | $ 55.00 | 3900 | $ 214,500.00 | |
| **Subtotal for Subcontractors - Task 5** | | | | **$ 3,198,000.00** |
| | | | | |
| **Task 6 - In-Situ Confirmation Sampling** | | | | |
| Subcontractor (CalScience) Stockpile Samples | | | | |
| Pesticides/Herbicides (EPA Method 8080) 24 hour TAT | $ 300.00 | 42 | $ 12,600.00 | |
| Dioxins (EPA Method 8280) 24 hour TAT | $ 700.00 | 42 | $ 29,400.00 | |
| Title 22 Metals (EPA Method 6010/7000) 24 hour TAT | $ 230.00 | 42 | $ 9,660.00 | |
| **Subtotal for Subcontractors - Task 6** | | | | **$ 51,660.00** |
| | | | | |

**Table F1-5**
**Site 1A-1**
**Excavation, Soil Pre-treatment, Backfill, and off-Base Disposal**
**Detailed Subcontractor Costs Costs**

| Description of Subcontractor Costs<br>Standard Billing Rate ($/hr) | Unit Rate | Units | Subtotal | Total Subcontractor Costs |
|---|---|---|---|---|
| **Task 7 - Backfill and Compaction** | | | | |
| Subcontractor (WMI) | | | | |
| Backfill Material (tons of backfill material) | $ 15.00 | 39000 | $ 585,000.00 | |
| Subcontractor (NRC Env) 39 Working Days @ 8 Hours/day for Backfill and Compaction of Material | | | | |
| Project Manager (0.5) Hourly | $ 115.00 | 156 | $ 17,940.00 | |
| Project Superintendent (1) Hourly | $ 97.75 | 312 | $ 30,498.00 | |
| Operator (2) Hourly | $ 72.45 | 624 | $ 45,208.80 | |
| Driver (1) Hourly | $ 72.45 | 312 | $ 22,604.40 | |
| Laborer (2) Hourly | $ 51.75 | 624 | $ 32,292.00 | |
| D-6 Dozer (1) Daily including fuel | $ 805.00 | 39 | $ 31,395.00 | |
| Roller Compactor (1) Daily including fuel | $ 747.50 | 39 | $ 29,152.50 | |
| Water Trucks, 4,000 Gallon (1) Daily including fuel | $ 603.75 | 39 | $ 23,546.25 | |
| NRC Env Other Direct Costs | $ 250.00 | 39 | $ 9,750.00 | |
| Subcontractor (Smith Emery) 39 Working Days @ 8 Hours/day for Backfill and Compaction of Material | | | | |
| Project Manager (1 hour per day) Hourly | $ 100.00 | 39 | $ 3,900.00 | |
| Soils Technician (1) Hourly | $ 80.00 | 312 | $ 24,960.00 | |
| Smith Emery Other Direct Costs | $ 250.00 | 39 | $ 9,750.00 | |
| Subcontractor (Surveying) | $ 25,000.00 | 1 | $ 25,000.00 | |
| Subcontractor (Revegetation) | $ 100,000.00 | 1 | $ 100,000.00 | |
| **Subtotal for Subcontractors - Task 7** | | | | **$ 990,996.95** |
| **ODC Subcontractor Total** | | | | **$ 5,839,762.95** |

# APPENDIX F2
# COST ESTIMATES FOR THE SITE 1111 SOIL ALTERNATIVES

## F2 COST ESTIMATES FOR THE SITE 1111 SOIL ALTERNATIVES

This section provides the cost estimates for the soil remedial action alternatives for Site 1111 described in Section 4 of the main document. A summary of the total cost for each of the Site 1111 alternatives is presented in Table F2-1.

As a necessary precursor to estimating costs for Site 1111, the FS investigation evaluated soil potentially requiring remediation from the standpoint of waste type (classification) and volume (lateral and vertical extent). Based on the concentrations for soil that exceeded the remedial goals (RGs), the soil was preliminarily classified as RCRA-hazardous, California-hazardous, or non-hazardous waste. The waste classifications would only apply upon generation of a solid waste following excavation of the material (i.e., the material would not classify as a "waste" if left in situ). As such, the waste classifications are potentially relevant to soil excavated during site remediation.

Preliminary waste classification assumptions are provided on the cost tables.

The estimated volume of soil exceeding RGs at Site 1111 was approximately 1,100 cubic yards. Of the impacted material, approximately 50 percent of the total was above the RCRA-hazardous criteria.

Using the estimated volumes and preliminary classifications (where appropriate), the cost estimates for the site-specific remedial alternatives were developed as discussed below.

### F2.1 Alternative 1111-S1: No Action

This alternative involves no additional actions to mitigate current site conditions and thus, has no cost associated with it.

### F2.2 Alternative 1111-S2: Institutional Controls

Alternative 1111-S2 involves implementation of land use restrictions, monitoring the site for erosion and compliance with land use restrictions, and monitoring potential ecological impacts. To help ensure that this alternative is protective of ecological receptors, periodic biological surveys would be performed and a detailed, site-specific ecological risk assessment including collection of faunal tissue samples would be conducted. The capital and annual O&M cost estimates are presented in Table F2-2.

The following are alternative-specific assumptions for Alternative 1111-S2:

- Capital cost includes a lump sum for administrative measures required for implementation of land use controls (estimated to be $75,000).
- Annual O&M costs include site monitoring for erosion control, continued compliance with land use restrictions, and potential ecological impacts.

If institutional controls were implemented, there would be indirect costs associated with the Base not being able to use the property for training and other purposes. Given that the Base mission is to support training, any area with a land use restriction would limit that function. This potential loss of land use is not quantified in this document, but is considered as a factor in evaluating implementability of institutional controls as a remedial alternative.

In summary, the estimated total cost of the alternative, which includes capital and O&M costs, is $295,000.

## F2.3 Alternative 1111-S3: Soil Excavation, Backfill, and Off-Base Disposal

Alternative 1111-S3 involves the excavation and off-Base disposal of impacted soil. The approximate costs for a single excavation scenario were evaluated, involving excavation to the (variable) bottom of the burn debris, typically 5 to 15 ft bgs. Estimated costs are presented in Tables F2-3 and F2-4 and the underlying assumptions are summarized below:

- Access to site is granted without restriction.
- Approximately 1,100 cubic yards of material would require excavation (approximately 5,000 square feet multiplied by the average depth of contamination, estimated at about 6 feet).
- Approximate conversion factor from in situ cubic yards to ex situ cubic yards equals 1.3.
- Approximate conversion factor from cubic yards to tons equals 1.5.
- Confirmation stockpile samples would be collected at a rate of one per every 500 tons of soil.
- Confirmation stockpile samples would be analyzed for soluble lead (STLC/TCLP).
- Materials with total lead concentrations less than 350 mg/kg and STLC concentrations less than 5.0 mg/L would be disposed of at the Waste Management Bradley facility as non-hazardous.
- Materials that have total lead concentrations greater than 350 mg/kg or STLC concentrations greater than 5.0 mg/L and TCLP concentrations less than 5.0 mg/L would be disposed of at the Waste Management Kettleman Hills facility as California-hazardous.
- Materials with TCLP concentrations greater than 5.0 mg/L would be stabilized and disposed of at the Waste Management Kettleman Hills facility as RCRA-hazardous.
- Portable scales would be used on site to weigh trucks so that trucks leaving the Base would not need to be weighed using the Base scales.
- Air samples would be collected daily for the duration of the project. Four area air samples and three personal air samples would be collected each day of sampling.
- Manifests would be signed by a designated Base representative.
- Approximately 600 tons of material would be removed from the site daily.
- Personnel working in the stabilization processing area would wear air-purifying respirators, chemically resistant gloves, and Tyvek for personal protective equipment.
- Work stoppages associated with Base restrictions have not been included in this cost estimate.
- One confirmation sample would be collected below the excavated areas representing 400 square feet (20-foot by 20-foot grid) to confirm the effectiveness of this remedial alternative.

- Work would be performed during the day on 5-day/8-hour work shifts. No costs for overtime hours or off hours work has been included in this cost estimate.
- Workers would be paid at prevailing wage rates.

In summary, the estimated total cost for Alternative 1111-S3 is $699,000 for excavation to the (variable) bottom of the burn debris. Because the costs would be incurred over a relatively short time frame (i.e., less than one year), O&M is not anticipated.

## Table F2-1
## Site 1111
## Summary of Total Cost of Alternatives for Soil

| Alternative | Description | Total O&M ($) | Capital Cost ($) | Total Cost ($) |
|---|---|---|---|---|
| S1 | No Action | 0 | 0 | 0 |
| S2 | Institutional Controls | 220,000 | 75,000 | 295,000 |
| S3 | Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal | 0 | 711,400 | 711,400 |

# Table F2-2
# Site 1111
# Alternative 1111-S2: Institutional Controls
# Cumulative Cost Estimate

| Year | Annual O&M[a] ($) | Capital[b] ($) | Cumulative Cost ($) |
|---|---|---|---|
| 0 | 0 | 75,000 | 75,000 |
| 1 | 5,000 | 0 | 80,000 |
| 2 | 5,000 | 0 | 85,000 |
| 3 | 5,000 | 0 | 90,000 |
| 4 | 15,000 | 0 | 105,000 |
| 5 | 5,000 | 0 | 110,000 |
| 6 | 5,000 | 0 | 115,000 |
| 7 | 5,000 | 0 | 120,000 |
| 8 | 15,000 | 0 | 135,000 |
| 9 | 5,000 | 0 | 140,000 |
| 10 | 5,000 | 0 | 145,000 |
| 11 | 5,000 | 0 | 150,000 |
| 12 | 15,000 | 0 | 165,000 |
| 13 | 5,000 | 0 | 170,000 |
| 14 | 5,000 | 0 | 175,000 |
| 15 | 5,000 | 0 | 180,000 |
| 16 | 15,000 | 0 | 195,000 |
| 17 | 5,000 | 0 | 200,000 |
| 18 | 5,000 | 0 | 205,000 |
| 19 | 5,000 | 0 | 210,000 |
| 20 | 15,000 | 0 | 225,000 |
| 21 | 5,000 | 0 | 230,000 |
| 22 | 5,000 | 0 | 235,000 |
| 23 | 5,000 | 0 | 240,000 |
| 24 | 15,000 | 0 | 255,000 |
| 25 | 5,000 | 0 | 260,000 |
| 26 | 5,000 | 0 | 265,000 |
| 27 | 5,000 | 0 | 270,000 |
| 28 | 15,000 | 0 | 285,000 |
| 29 | 5,000 | 0 | 290,000 |
| 30 | 5,000 | 0 | 295,000 |
| **TOTAL FOR ALTERNATIVE 2** | | **75,000** | **295,000** |

[a]Annual O&M costs include site monitoring for erosion, land use, and ecological impact, and quadrennial surveys.

[b]Capital cost includes a lump sum cost for adminstrative measures required for implementation of land use controls (estimated to be $75,000).

**Table F2-3**
**Site 1111**
**Alternative 1111-S3: Excavation, Backfill, and off-Base Disposal**
**Total Estimated Costs**

| Professional Category | Sr. Tech. Dir. | Proj. Mgr. | Sup. Engineer | Sr. Engineer | Engineer | Sup. Scientist | Sr. Scientist | Scientist | Sup. Specialist | Sr. Spec. I | Total Hours | Total Labor $ | Total ODCs $ | Subtotal Cost | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard Billing Rate ($/hr) | $126.07 | $114.39 | $115.40 | $86.98 | $65.95 | $109.09 | $69.62 | $53.41 | $73.90 | $42.57 | | | | | |
| **Task 1 - Planning, Direction, Oversight, Scheduling, Meetings, and Scope Preparation** | | | | | | | | | | | | | | | |
| Planning | 4 | 20 | 20 | 0 | 0 | 20 | 0 | 0 | 10 | 10 | 84 | $ 8,446.58 | $ - | $ 8,446.58 | |
| Direction and Oversight | 4 | 8 | 8 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 28 | $ 3,215.32 | $ - | $ 3,215.32 | |
| Schedule Preparation and Implementation | 4 | 8 | 8 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 28 | $ 3,215.32 | $ - | $ 3,215.32 | |
| Meetings | 4 | 8 | 8 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 28 | $ 3,215.32 | $ - | $ 3,215.32 | |
| Scope Preparation | 4 | 8 | 8 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 28 | $ 3,215.32 | $ - | $ 3,215.32 | |
| ODCs - Subcontractors | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 3,000.00 | $ 3,000.00 | |
| **Total Cost for Task 1** | | | | | | | | | | | | | | | $ 24,307.86 |
| **Task 2 - Mobilization** | | | | | | | | | | | | | | | |
| Mobilization | 2 | 4 | 4 | 0 | 20 | 4 | 0 | 20 | 0 | 0 | 54 | $ 3,994.86 | $ - | $ 3,994.86 | |
| ODC - Subcontractor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 10,000.00 | $ 10,000.00 | |
| **Total Cost for Task 2** | | | | | | | | | | | | | | | $ 13,994.86 |
| **Task 3 - Excavation/Stockpiling of Impacted Soil** | | | | | | | | | | | | | | | |
| Excavation Oversight | 4 | 20 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 64 | $ 7,408.08 | $ - | $ 7,408.08 | |
| Soil Stockpile Confirmation Sampling | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 40 | 0 | 0 | 80 | $ 4,774.40 | $ - | $ 4,774.40 | |
| Air Monitoring | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ - | $ - | |
| ODC - Subcontractor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 70,942.75 | $ 70,942.75 | |
| **Total Cost for Task 3** | | | | | | | | | | | | | | | $ 83,125.23 |
| **Task 4 - Transport and Disposal of Soil** | | | | | | | | | | | | | | | |
| Manifest Tracking and Oversight | 4 | 20 | 40 | 0 | 40 | 0 | 0 | 40 | 0 | 0 | 144 | $ 12,182.48 | $ - | $ 12,182.48 | |
| ODC - Subcontractor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 258,500.00 | $ 258,500.00 | |
| **Total Cost for Task 4** | | | | | | | | | | | | | | | $ 270,682.48 |
| **Task 5 - In-Situ Confirmation Sampling** | | | | | | | | | | | | | | | |
| Sample Collection | 0 | 4 | 10 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 34 | $ 2,930.56 | $ - | $ 2,930.56 | |
| ODC-Subcontractor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 27,720.00 | $ 27,720.00 | |
| **Total Cost for Task 5** | | | | | | | | | | | | | | | $ 30,650.56 |
| **Task 6 - Backfill and Compaction** | | | | | | | | | | | | | | | |
| Backfill/Compaction Oversight | 0 | 10 | 40 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 90 | $ 8,397.90 | $ - | $ 8,397.90 | |
| ODC - Subcontractor | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 99,025.25 | $ 99,025.25 | |
| **Total Cost for Task 6** | | | | | | | | | | | | | | | $ 107,423.15 |
| **Task 7 - Reporting** | | | | | | | | | | | | | | | |
| Draft Report Preparation | 4 | 40 | 40 | 20 | 0 | 20 | 0 | 20 | 20 | 20 | 184 | $ 18,333.88 | $ - | $ 18,333.88 | |
| Incorporate Comments from MCB and Regulators | 2 | 20 | 20 | 10 | 0 | 10 | 0 | 10 | 10 | 10 | 92 | $ 9,166.94 | $ - | $ 9,166.94 | |
| Finalize Report | 2 | 10 | 10 | 10 | 0 | 10 | 0 | 10 | 10 | 10 | 72 | $ 6,869.04 | $ - | $ 6,869.04 | |
| **Total Cost for Task 7** | | | | | | | | | | | | | | | $ 34,369.86 |
| **Other Direct Costs - Parsons (5% of Project Total)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $ - | $ 28,227.70 | $ 28,227.70 | $ 28,227.70 |
| **Contingency (20%=10%[Bid]+10%[Scope])** | | | | | | | | | | | | | | | $ 118,556.34 |
| **Total** | 38 | 180 | 256 | 40 | 160 | 96 | 0 | 140 | 50 | 50 | 1010 | $ 95,366.00 | $ 497,415.70 | | $ 711,338.04 |

**ASSUMPTIONS:**

Access to site is granted without restriction
Conversion factor from in-situ cubic yards to ex-situ cubic yards (fluff) = 1 3
Conversion factor from cubic yards to tons = 1 5
Confirmation samples will be collected from stockpiles to determine ultimate disposition of soil (1 per 500 tons)
Confirmation stockpile samples will be analyzed for soluble metals, soluble dioxins and soluble pesticides (STLC/TCLP)
Materials with total concentrations <10 X the STLC will be deposited at Waste Management Bradley Facility as Non-Haz
Materials with total concentrations >10 X the STLC will be analyzed using a Waste Extraction Test (WET). Results from the WET will be compared to the STCL value for the individual constituent If WET results exceed the STLC a Toxicity Characteristic Leaching Potential (TCLP) test will be performed.
Materials with WET concentrations greater than the STLC but less than the TCLP will be deposited in the Waste Management Kettleman Hills Facility as CA-Haz
Materials with concentrations greater than the TCLP will be transported and disposed at the Waste Management Kettleman Hills Facility as RCRA-Haz
Portable scales will be used on-site to weigh trucks so that trucks leaving the Base will not need to be weighed using the Base scales
Air samples will be collected on a daily basis for the duration of the project Four area air samples and three personal air samples will be collected each day of sampling
Manifests will be signed by a designated Base representative
Approximately 500 tons of material will be removed from the Site on a daily basis
Work stoppages associated with Base restrictions have not been included in this cost estimate
Confirmation samples will be collected which will be representative of approximately 400 square feet (20'X20') to confirm the effectiveness of this remedial alternative
Work will be performed during the day on 5-day/8-hour work shifts No costs for overtime hours or off hours work has been included in this cost estimate
Workers will be paid at prevailing wage rates
50% of Material removed will be RCRA Hazardous
50% of Material removed will be CA Hazardous

**Table F2-4**
**Site 1111**
**Alternative 1111-S3: Excavation, Backfill, and off-Base Disposal**
**Detailed Subcontractor Costs Costs**

| Description of Subcontractor Costs<br>Standard Billing Rate ($/hr) | Unit Rate | Units | Subtotal | Total Subcontractor Costs |
|---|---|---|---|---|
| **Task 1 - Planning, Direction, Oversight, Scheduling, Meetings, and Scope Preparation** | | | | |
| Subcontractor (WMI) | $ 1,000.00 | 1 | $ 1,000.00 | |
| Subcontractor (NRC Env) | $ 1,000.00 | 1 | $ 1,000.00 | |
| Subcontractor (CalScience) | $ 1,000.00 | 1 | $ 1,000.00 | |
| **Subtotal for Subcontractors - Task 1** | | | | **$ 3,000.00** |
| | | | | |
| **Task 2 - Mobilization (Lump Sum)** | | | | |
| Subcontractor (NRC Env) | $ 10,000.00 | 1 | $ 10,000.00 | |
| **Subtotal for Subcontractors - Task 2** | | | | **$ 10,000.00** |
| | | | | |
| **Task 3 - Excavation/Stockpiling/Loading of Impacted Soil** | | | | |
| Subcontractor (NRC Env) 5 Working Days @ 8 Hours/day for Excavation of Material | | | | |
| Project Manager (0.5) Hourly | $ 115.00 | 20 | $ 2,300.00 | |
| Project Superintendent (1) Hourly | $ 97.75 | 40 | $ 3,910.00 | |
| Operator (2) Hourly | $ 72.45 | 80 | $ 5,796.00 | |
| Driver (1) Hourly | $ 72.45 | 40 | $ 2,898.00 | |
| Laborer (2) Hourly | $ 51.75 | 80 | $ 4,140.00 | |
| CAT 235 Trackhoe (1) Daily including fuel | $ 1,115.50 | 5 | $ 5,577.50 | |
| CAT 950 Loader (1) Daily including fuel | $ 632.50 | 5 | $ 3,162.50 | |
| Water Trucks, 4,000 Gallon (1) Daily including fuel | $ 603.75 | 5 | $ 3,018.75 | |
| NRC Env Other Direct Costs | $ 250.00 | 5 | $ 1,250.00 | |
| Subcontractor (CalScience) Stockpile Samples | | | | |
| VOCs (EPA Method 8260) 24 hour TAT | $ 250.00 | 5 | $ 1,250.00 | |
| SVOCs (EPA Method 8270) 24 hour TAT | $ 500.00 | 5 | $ 2,500.00 | |
| Pesticides/Herbicides (EPA Method 8080) 24 hour TAT | $ 300.00 | 5 | $ 1,500.00 | |
| Title 22 Metals (EPA Method 6010/7000) 24-hour TAT | $ 230.00 | 5 | $ 1,150.00 | |
| STLC (Waste Extraction Test and Analysis) 24-hour TAT | $ 92.00 | 5 | $ 460.00 | |
| TCLP (TCLP Extraction and Analysis) 24-hour TAT | $ 92.00 | 5 | $ 460.00 | |
| Subcontractor (EMS) Air Monitoring Samples | | | | |
| Metals Analysis (except hex chromium) 24 hour TAT | $ 92.00 | 35 | $ 3,220.00 | |
| Metals Analysis (hex chromium) 24 hour TAT | $ 92.00 | 35 | $ 3,220.00 | |
| Total Dust 24 hour TAT | $ 30.00 | 35 | $ 1,050.00 | |
| Respirable Dust 24 hour TAT | $ 30.00 | 35 | $ 1,050.00 | |
| Total Silica (includes crocidolite and trydimite) 24 hour TAT | $ 329.00 | 35 | $ 11,515.00 | |
| Respirable Silica (includes crocidolite and trydimite) 24 hour TAT | $ 329.00 | 35 | $ 11,515.00 | |
| **Subtotal for Subcontractors - Task 3** | | | | **$ 70,942.75** |
| | | | | |
| **Task 4 - Transport and Disposal of Soil** | | | | |
| Subcontractor (WMI) | | | | |
| Transport and Disposal of RCRA Hazardous Material to WMI Kettleman Hills Facility | $ 150.00 | 1100 | $ 165,000.00 | |
| Transport and Disposal of CA Hazardous Material to WMI Kettleman Hills Facility | $ 85.00 | 1100 | $ 93,500.00 | |
| **Subtotal for Subcontractors - Task 4** | | | | **$ 258,500.00** |
| | | | | |
| **Task 5 - In-Situ Confirmation Sampling** | | | | |
| Subcontractor (CalScience) Stockpile Samples | | | | |
| VOCs (EPA Method 8260) 24 hour TAT | $ 250.00 | 14 | $ 3,500.00 | |
| SVOCs (EPA Method 8270) 24 hour TAT | $ 500.00 | 14 | $ 7,000.00 | |
| Dioxins (EPA Method 8280) 24 hour TAT | $ 700.00 | 14 | $ 9,800.00 | |
| Pesticides/Herbicides (EPA Method 8080) 24 hour TAT | $ 300.00 | 14 | $ 4,200.00 | |
| Title 22 Metals (EPA Method 6010/7000) 24 hour TAT | $ 230.00 | 14 | $ 3,220.00 | |
| **Subtotal for Subcontractors - Task 5** | | | | **$ 27,720.00** |
| | | | | |
| **Task 6 - Backfill and Compaction** | | | | |
| Subcontractor (WMI) | | | | |
| Backfill Material | $ 15.00 | 2200 | $ 33,000.00 | |
| Subcontractor (NRC Env) 5 Working Days @ 8 Hours/day for Backfill and Compaction of Material | | | | |
| Project Manager (0.5) Hourly | $ 115.00 | 20 | $ 2,300.00 | |
| Project Superintendent (1) Hourly | $ 97.75 | 40 | $ 3,910.00 | |
| Operator (2) Hourly | $ 72.45 | 80 | $ 5,796.00 | |
| Driver (1) Hourly | $ 72.45 | 40 | $ 2,898.00 | |
| Laborer (2) Hourly | $ 51.75 | 80 | $ 4,140.00 | |
| D-6 Dozer (1) Daily including fuel | $ 805.00 | 5 | $ 4,025.00 | |
| Roller Compactor (1) Daily including fuel | $ 747.50 | 5 | $ 3,737.50 | |
| Water Trucks, 4,000 Gallon (1) Daily including fuel | $ 603.75 | 5 | $ 3,018.75 | |
| NRC Env Other Direct Costs | $ 250.00 | 5 | $ 1,250.00 | |
| Subcontractor (Smith Emery) 5 Working Days @ 8 Hours/day for Backfill and Compaction of Material | | | | |
| Project Manager (1 hour per day) Hourly | $ 100.00 | 5 | $ 500.00 | |
| Soils Technician (1) Hourly | $ 80.00 | 40 | $ 3,200.00 | |
| Smith Emery Other Direct Costs | $ 250.00 | 5 | $ 1,250.00 | |
| Subcontractor (Surveying) | $ 5,000.00 | 1 | $ 5,000.00 | |
| Subcontractor (Revegetation) | $ 25,000.00 | 1 | $ 25,000.00 | |
| **Subtotal for Subcontractors - Task 6** | | | | **$ 99,025.25** |
| **ODC Subcontractor Total** | | | | **$ 469,188.00** |

# APPENDIX F3
# COST ESTIMATES FOR THE
# SITE 1111 GROUNDWATER ALTERNATIVES

## F3 COST ESTIMATES FOR THE SITE 1111 GROUNDWATER ALTERNATIVES

This section provides the cost estimates for the groundwater remedial action alternatives for Site 1111 described in Section 3 of the main document. A summary of the total cost for each of the Site 1111 alternatives is presented in Table F3-1.

Groundwater Alternatives 1111-G3 and 1111-G4 include the costs for the soil Alternative 1111-S3, Soil Excavation, Backfill, Pretreatment, and Off-Base Disposal, as detailed in Tables F2-3 and F2-4 with an estimated cost of $699,000.

### F3.1 Alternative 1111-G1: No Action

This alternative involves no additional actions to mitigate current site conditions and thus, has no cost associated with it.

### F3.2 Alternative 1111-G2: Institutional Controls with Long-Term Groundwater Monitoring

Alternative 1111-G2 involves groundwater monitoring and implementation of use restrictions after soil source removal (Alternative 1111-S3). The capital and annual O&M cost components are estimated in Table F3-2, and the cumulative cost is presented in Table F3-3.

The following are alternative-specific assumptions for Alternative 1111-G2:

- Capital costs include preparation of the work plan, including the SAP, QAPP, HSP, and Long-Term Monitoring Plan.
- Two new monitoring wells would be installed up to 20 feet deep.
- Baseline groundwater monitoring would be performed semiannually for the first year on seven existing wells and two new wells throughout Site 1111 (see Table 3-3 of the text for a list of the wells).
- The Long-Term Monitoring Plan includes five wells (three existing and two new) (see Table 3-3 of the text for a list of the wells). Groundwater monitoring would be performed for VOCs semiannually during the first 2 years of sampling, annually during years 3 through 5, and biannually thereafter. Included in the Long-Term Monitoring Plan are groundwater level measurements at all site wells (nine total).
- For cost estimating purposes, 3 years of long-term monitoring was assumed to reach MCLs and 5 years to reach background.

In summary, the total cost for Alternative 1111-G2 includes capital and O&M costs. The estimated total cost to reach MCLs in 3.4 years is $185,000 and the estimated total cost to reach background in 4.9 years is $196,100.

### F3.3 Alternative 1111-G3: Monitored Natural Attenuation with Alternative G2

Alternative 1111-G3 involves monitored natural attenuation in addition to groundwater monitoring and use restrictions. The capital and annual O&M cost components are estimated in Table F3-4, and the cumulative cost is presented in Table F3-5.

In addition to the assumptions for Alternative 1111-G2, the following are alternative-specific assumptions for Alternative 1111-G3:

- Two new monitoring wells would be installed up to 20 feet deep.
- Baseline MNA sampling would be performed semiannually for the first year on seven existing site wells and the four new wells throughout the site. Table 3-3 in the text list the wells and target monitoring zone. All of the wells to be sampled, except two new wells, are included in the sampling program for Alternative 1111-G3 and therefore costs to sample and analyze for VOCs for these wells are excluded from this alternative and only the costs for geochemical analysis of these wells are included.
- The Long-Term Monitoring Plan includes seven wells (see Table 3-3 of the text for a list of the wells). Groundwater monitoring would be performed for VOCs and geochemical parameters semiannually during the first two years of sampling and annually during years 3 through 5. Included in the Long-Term Monitoring Plan are groundwater level measurements at all MNA wells, including the pond surface.
- For cost estimating purposes, 3 years of long-term monitoring was assumed to reach MCLs and 5 years to reach background.

In summary, the total cost for Alternative 1111-G3 includes capital and O&M costs. The estimated total cost to reach MCLs in 3.4 years is $267,700 and the estimated total cost to reach background in 4.9 years is $306,200.

### F3.4 Alternative 1111-G4: Enhanced Attenuation via Carbon Addition in Source Area with Alternative G3

Alternative 1111-G4 involves enhanced attenuation via carbon addition in the source area in addition to MNA and use restrictions. The capital and annual O&M cost components are estimated in Table F3-6, and the cumulative cost is presented in Table F3-7.

In addition to the assumptions for Alternatives 1111-G2 and 1111-G3, the following are alternative-specific assumptions for Alternative 1111-G4:

- A work plan will be prepared to include design of remediation system and application.
- One-time installation of solid organic substrate would be required at the base of the excavation area. Approximately a 1-foot thick layer of substrate will be installed for an estimated 200 cubic yards.
- Eleven 18 cubic yard trucks will delivery the substrate to the site. It will take 3 days to unload substrate from trucks into the excavation pit.
- For cost estimating purposes, 3 years of long-term monitoring was assumed for MCLs and 5 years for background.

In summary, the total cost for Alternative 1111-G4 includes capital and O&M costs. The estimated total cost to reach MCLs in 2.6 years is $306,600 and the estimated total cost to reach background in 4.1 years is $345,100.

## Table F3- 1
## Site 1111
## Summary of Total Cost of Alternatives for Groundwater

| Alternative | Description | Estimated Duration (Years) | O&M Cost ($) | Capital Cost ($) | Total Cost ($) |
|---|---|---|---|---|---|
| 1 | No Action | | 0 | 0 | 0 |
| 2 | Institutional Controls and Long-Term Groundwater Monitoring | 3.4 | 75,000 | 110,000 | 185,000 |
| | | 4.9 | 86,100 | 110,000 | 196,100 |
| 3 | Monitored Natural Attenuation with Alternative 1111-G2 | 3.4 | 107,100 | 160,600 | 267,700 |
| | | 4.9 | 145,600 | 160,600 | 306,200 |
| 4 | Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3 | 2.6 | 107,100 | 199,500 | 306,600 |
| | | 4.1 | 145,600 | 199,500 | 345,100 |

Note: Alternatives 2, 3, and 4 include Soil Alternative 1111-S3, Excavation with an estimated net present worth of $711,400.

## Table F3-2
## Site 1111
## Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring
## Total Estimated Costs

| | Unit | Quantity | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Capital Cost** | | | | |
| Work Plan (SAP, QAPP, HSP, LTMP) | lump sum | | | 15,000 |
| Institutional Control Plan | lump sum | | | 10,000 |
| Navy/Agency Comments/Meetings | lump sum | | | 40,000 |
| Well Installation : | | | | |
| Mobilization/Demobilization | lump sum | | | 1,500 |
| Permits, Well (DHS) | each | 2 | 160 | 320 |
| Subsurface Clearance | day | 1 | 2,000 | 2,000 |
| Monitoring Well (20 feet) [1] | well | 2 | 190 | 380 |
| Survey | days | 1 | 2,000 | 2,000 |
| IDW Disposal | drums | 3 | 55 | 165 |
| Well Installation Report | lump sum | | | 12,000 |
| Project Management at 10% | | | | 8,337 |
| | | | Subtotal | 91,702 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 18,340 |
| | | | **Total Capital Cost** | **110,042** |
| **Baseline Sampling Cost (year 1)** | | | | |
| Analytical: (7 existing and 2 new - semiannual) | | | | |
| VOCs [1] | number | 22 | 130 | 2,860 |
| Equipment | day | 6 | 350 | 2,100 |
| IDW Disposal [2] | drum | 6 | 50 | 300 |
| Maintenance | lump sum | | | 1,000 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 96 | 65 | 6,240 |
| Car rental | day | 6 | 65 | 390 |
| Hotel | day | 12 | 100 | 1,200 |
| Expenses | day | 12 | 45 | 540 |
| Data Validation | lump sum | | | 2,500 |
| Reports | lump sum | | | 7,000 |
| Project Management at 10% | | | | 2,413 |
| | | | Subtotal | 26,543 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 5,309 |
| | | | **Total Baseline Sampling Cost (year 1)** | **31,852** |

## Table F3-2
## Site 1111
## Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring
## Total Estimated Costs

| | Unit | Quantity | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Annual O&M Cost (year 2)** | | | | |
| Analytical: (5 wells, semiannual) | | | | |
| VOCs | number | 12 | 130 | 1,560 |
| Equipment | day | 4 | 350 | 1,400 |
| IDW Disposal[1] | drum | 3 | 50 | 150 |
| Maintenance | lump sum | | | 700 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 64 | 65 | 4,160 |
| Car rental | day | 4 | 65 | 260 |
| Hotel | day | 8 | 100 | 800 |
| Expenses | day | 8 | 45 | 360 |
| Data Validation | lump sum | | | 1,500 |
| Reports | lump sum | | | 5,000 |
| Project Management at 10% | | | | 1,589 |
| | | | Subtotal | 17,479 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 3,496 |
| | | | **Total Annual Cost (year 2)** | **20,975** |
| **Annual O&M Cost (years 3 - 5)** | | | | |
| Analytical: (5 wells, annual) | | | | |
| VOCs | number | 6 | 130 | 780 |
| Equipment | day | 2 | 350 | 700 |
| IDW Disposal[1] | drum | 2 | 50 | 100 |
| Maintenance | lump sum | | | 500 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 32 | 65 | 2,080 |
| Car rental | day | 2 | 65 | 130 |
| Hotel | day | 4 | 100 | 400 |
| Expenses | day | 4 | 45 | 180 |
| Data Validation | lump sum | | | 1,000 |
| Reports | lump sum | | | 2,500 |
| Project Management at 10% | | | | 837 |
| | | | Subtotal | 9,207 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 1,841 |
| | | | **Total Annual Cost (years 3 – 5)** | **11,048** |

Assumptions:

1. Low-flow purging and sampling assumed.

## Table F3-3
## Site 1111
## Alternative 1111-G2: Institutional Controls and Long-Term Groundwater Monitoring Cumulative Cost

| Year | Annual O&M ($) | Capital ($) | Cumulative Cost ($) |
|---|---|---|---|
| 0 | 0 | 110,042 | 110,042 |
| 1 | 31,852 | 0 | 141,893 |
| 2 | 20,975 | 0 | 162,868 |
| 3 | 11,048 | 0 | 173,917 |
| 4 | 11,048 | 0 | 184,965 |
| 5 | 11,048 | 0 | 196,013 |
| | | **Total (MCLs - 3 years)** | **173,917** |
| | | **Total (Background - 5 years)** | **196,013** |

## Table F3-4
## Site 1111
## Alternative 1111-G3: Monitored Natural Attenuation with Alternative 1111-G2
## Total Estimated Costs

| | Unit | Quantity | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Capital Cost** | | | | |
| Work Plan (SAP, QAPP, HSP, LTMP) | lump sum | | | 10,000 |
| Navy/Agency Comments/Meetings | lump sum | | | 10,000 |
| Well Installation : | | | | |
| Mobilization/Demobilization | lump sum | | | 1,500 |
| Permits, Well (DHS) | each | 2 | 160 | 320 |
| Subsurface Clearance | day | 1 | 2,000 | 2,000 |
| Monitoring Well (20 feet) [1] | well | 2 | 190 | 380 |
| Survey | days | 1 | 2,000 | 2,000 |
| IDW Disposal [2] | drums | 3 | 55 | 165 |
| Well Installation Report | lump sum | | | 12,000 |
| Project Management at 10% | | | | 3,837 |
| | | | Subtotal | 42,202 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 8,440 |
| | | | **Total Capital Cost** | **50,642** |
| **Baseline Sampling Cost (year 1)** | | | | |
| Costs include Alternative 2 Baseline Sampling Cost (year 1) with the addition of the following: | | | | |
| Analytical: (2 new - semiannual) | | | | |
| VOCs [3] | number | 5 | 130 | 650 |
| Geochemical Analyses | number | 22 | 290 | 6,380 |
| Equipment | day | 2 | 350 | 700 |
| IDW Disposal [2] | drum | 2 | 50 | 100 |
| Maintenance | lump sum | | | 500 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 32 | 65 | 2,080 |
| Car rental | day | 2 | 65 | 130 |
| Hotel | day | 4 | 100 | 400 |
| Expenses | day | 4 | 45 | 180 |
| Data Validation | lump sum | | | 750 |
| Reports | lump sum | | | 2,500 |
| Project Management at 10% | | | | 1,437 |
| | | | Subtotal | 15,807 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 3,161 |
| | | | **Total Baseline Sampling Cost (year 1)** | **18,968** |

## Table F3-4
## Site 1111
## Alternative 1111-G3: Monitored Natural Attenuation with Alternative 1111-G2
## Total Estimated Costs

| | Unit | Quantity | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Annual O&M Cost (year 2)** | | | | |
| Analytical: (2 wells + wells from Alternative 2 - semiannual) | | | | |
| VOCs [3] | number | 5 | 130 | 650 |
| Geochemical Analyses | number | 14 | 290 | 4,060 |
| Equipment | day | 2 | 350 | 700 |
| IDW Disposal [2] | drum | 2 | 50 | 100 |
| Maintenance | lump sum | | | 500 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 32 | 65 | 2,080 |
| Car rental | day | 2 | 65 | 130 |
| Hotel | day | 4 | 100 | 400 |
| Expenses | day | 4 | 45 | 180 |
| Data Validation | lump sum | | | 750 |
| Reports | lump sum | | | 2,500 |
| Project Management at 10% | | | | 1,205 |
| | | | Subtotal | 13,255 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 2,651 |
| | | | **Total Annual Cost (year 2)** | **15,906** |
| **Annual O&M Costs (years 3 - 5)** | | | | |
| Analytical: (2 wells + wells from Alternative 2 - annual) | | | | |
| VOCs [3] | number | 3 | 130 | 390 |
| Geochemical Analyses | number | 7 | 290 | 2,030 |
| Equipment | day | 1 | 350 | 350 |
| IDW Disposal [2] | drum | 1 | 50 | 50 |
| Maintenance | lump sum | | | 250 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 16 | 65 | 1,040 |
| Car rental | day | 1 | 65 | 65 |
| Hotel | day | 2 | 100 | 200 |
| Expenses | day | 2 | 45 | 90 |
| Data Validation | lump sum | | | 500 |
| Reports | lump sum | | | 1,250 |
| Project Management at 10% | | | | 622 |
| | | | Subtotal | 6,837 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 1,367 |
| | | | **Total Annual Costs (years 3 – 5)** | **8,204** |

Assumptions:
1. Well costs include drilling, construction, decontamination, and well completion
2. Low-flow purging and sampling assumed
3. VOCs analysis includes an additional 20% for QA/QC samples.

## Table F3-5
## Site 1111
## Alternative 1111-G3: Monitored Natural Attenuation with Alternative 1111-G2
## Cumulative Cost

| Year | Annual O&M ($) | Capital ($) | Cumulative Cost ($) |
|---|---|---|---|
| 0 | 0 | 160,684 | 160,684 |
| 1 | 50,820 | 0 | 211,504 |
| 2 | 36,881 | 0 | 248,384 |
| 3 | 19,252 | 0 | 267,637 |
| 4 | 19,252 | 0 | 286,889 |
| 5 | 19,252 | 0 | 306,141 |
| | | **Total (MCLs - 3 years)** | **267,637** |
| | | **Total (Background - 5 years)** | **306,141** |

## Table F3-6
## Site 1111
## Alternative 1111-G4: Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3
## Total Estimated Costs

| | Unit | Quantity | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Capital Cost** | | | | |
| System Design and Work Plan | lump sum | | | 5,000 |
| Navy/Agency Comments/Meetings | lump sum | | | 5,000 |
| Solid Organic Substrate Installation: | | | | |
| Substrate Material [1] | cubic yard | 200 | 52 | 10,400 |
| Installation Equipment (loader) | day | 3 | 500 | 1,500 |
| System Installation Operator | hour | 24 | 110 | 2,640 |
| Engineering at 10-percent (including detailed design) | | | | 2,454 |
| Construction Administration at 10-percent | | | | 2,699 |
| Project Management at 10% | | | | 2,699 |
| | | | Subtotal | 32,393 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 6,479 |
| | | | **Total Capital Cost** | **38,871** |

Capital Costs and Annual O&M Costs for Institutional Actions and MNA are not included and are listed on Tables F4-2 and F4-4

Assumptions:

1. Includes delivery to the site

## Table F3-7
## Site 1111
## Alternative 1111-G4: Enhanced Attenuation Via Carbon Addition in Source Area with Alternative 1111-G3
## Cumulative Cost

| Year | Annual O&M ($) | Capital ($) | Cumulative Cost ($) |
|---|---|---|---|
| 0 | 0 | 199,555 | 199,555 |
| 1 | 50,820 | 0 | 250,375 |
| 2 | 36,881 | 0 | 287,256 |
| 3 | 19,252 | 0 | 306,508 |
| 4 | 19,252 | 0 | 325,760 |
| 5 | 19,252 | 0 | 345,012 |
| | | **Total (MCLs - 3 years)** | **306,508** |
| | | **Total (Background - 5 years)** | **345,012** |

# APPENDIX F4
# COST ESTIMATES FOR THE
# 12 AREA, SITE 13 GROUNDWATER ALTERNATIVES

## F4 COST ESTIMATES FOR THE 12 AREA, SITE 13 GROUNDWATER ALTERNATIVES

This section provides the cost estimates for the remedial action alternatives for 12 Area, Site 13 described in Section 4 of the main document. A summary of the total cost for each of the 12 Area, Site 13 alternatives is presented in Table F4-1.

### F4.1 Alternative 12A-1: No Action

This alternative involves no additional actions to mitigate current site conditions and thus, has no cost associated with it.

### F4.2 Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal

Alternative 12A-2 involves groundwater monitoring and implementation of use restrictions. The capital and annual O&M cost components are estimated in Table F4-2, and the cumulative cost is presented in Table F4-3.

The following are alternative-specific assumptions for Alternative 12A-2:

- Capital costs include preparation of the work plan, including the SAP, QAPP, HSP, and Long-Term Monitoring Plan.
- A system design and work plan would be prepared.
- One-time material installation would be required with minimal O&M for the first year.
- O&M labor would require one hour every two weeks during the first year only.
- Baseline groundwater monitoring would be performed semiannually for the first year on 15 existing wells throughout 12 Area (see Table 4-1 of the text for a list of the wells).
- The Long-Term Monitoring Plan includes five existing wells (see Table 4-1 of the text for a list of the wells). Groundwater monitoring would be performed for VOCs semiannually during the first 2 years of sampling, annually during years 3 through 5, and biannually thereafter. Included in the Long-Term Monitoring Plan are groundwater level measurements at all site wells (15 total).
- For cost estimating purposes, 20 years of long-term monitoring was assumed.

In summary, the total cost for Alternative 12A-2 includes capital and O&M costs. The best estimated total cost is $324,300 in 20 years. The factor that has a significant impact on the total cost is the length of remediation.

### F4.3 Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2

Alternative 12A-3 involves monitored natural attenuation in addition to groundwater monitoring, use restrictions, and product removal. The capital and annual O&M cost components are estimated in Table F4-4, and the cumulative cost is presented in Table F4-5.

In addition to the assumptions for Alternative 12A-2, the following are alternative-specific assumptions for Alternative 12A-3:

- Baseline MNA sampling would be performed semiannually for the first year on 15 existing site wells throughout the site. Table 4-2 in the text list the wells and target monitoring zone. All of the wells to be sampled are included in the sampling program for Alternative 12A-2 and therefore costs to sample and analyze for VOCs for these wells are excluded from this alternative.
- The Long-Term Monitoring Plan includes nine wells through year 5, which are then reduced to seven wells between years 6 through 10, and further reduced to five wells through year 20 (see Table 4-2 of the text for a list of the wells). Groundwater monitoring would be performed for VOCs and geochemical parameters semiannually during the first 2 years of sampling, annually during years 3 through 5, every 3 years during years 6 through 10, and every 6 years thereafter. Five of the wells to be sampled are included in the sampling program for Alternative 12A-2 and therefore costs to sample and analyze for VOCs for these wells are excluded from this alternative. Included in the Long-Term Monitoring Plan are groundwater level measurements at all MNA wells.
- For cost estimating purposes, 20 years of long-term monitoring was assumed.

In summary, the total cost for Alternative 12A-3 includes capital and O&M costs. The best estimated total cost is estimated to be $438,700 in 20 years.

## Table F4- 1
## 12 Area, Site 13 Groundwater
## Summary of Total Cost of Alternatives

| Alternative | Description | Estimated Duration (Years) | O&M Cost ($) | Capital Cost ($) | Cumulative Cost ($) |
|---|---|---|---|---|---|
| 1 | No Action | | 0 | 0 | 0 |
| 2 | Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal | 20 | 228,200 | 96,100 | 324,300 |
| 3 | Monitored Natural Attenuation with Alternative 2 | 20 | 316,200 | 122,500 | 438,700 |

## Table F4-2
## 12 Area, Site 13 Groundwater
## Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal
## Total Estimated Costs

| | Unit | Quantity | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Capital Cost** | | | | |
| Work Plan (SAP, QAPP, HSP, LTMP) | lump sum | | | 15,000 |
| Institutional Control Plan | lump sum | | | 10,000 |
| Navy/Agency Comments/Meetings | lump sum | | | 40,000 |
| Passive Recovery System Installation : | | | | |
| Passive Skimmer System | lump sum | | | 1,500 |
| System Installation | hour | 4 | 65 | 260 |
| Construction Administration at 10-percent | | | | 6,676 |
| Project Management at 10% | | | | 6,676 |
| | | | Subtotal | 80,112 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 16,022 |
| | | | **Total Capital Cost** | **96,134** |
| **Baseline Sampling and O&M Costs (year 1)** | | | | |
| Skimmer Equipment | lump sum | | | 300 |
| Product Recovery Labor | hour | 26 | 65 | 1,690 |
| Analytical: (15 existing - semiannual) | | | | |
| VOCs [1] | number | 36 | 130 | 4,680 |
| Equipment | day | 10 | 350 | 3,500 |
| IDW Disposal [2] | drum | 9 | 50 | 450 |
| Maintenance | lump sum | | | 1,000 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 160 | 65 | 10,400 |
| Car rental | day | 10 | 65 | 650 |
| Hotel | day | 20 | 100 | 2,000 |
| Expenses | day | 20 | 45 | 900 |
| Data Validation | lump sum | | | 4,000 |
| Reports | lump sum | | | 10,000 |
| Project Management at 10% | | | | 3,957 |
| | | | Subtotal | 43,527 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 8,705 |
| | | | **Total Baseline Sampling Costs (year 1)** | **52,232** |

## Table F4-2
## 12 Area, Site 13 Groundwater
## Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal
## Total Estimated Costs

| | Unit | Quantity | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Annual O&M Costs (year 2)** | | | | |
| Analytical: (5 wells - semiannual) | | | | |
| VOCs [1] | number | 12 | 130 | 1,560 |
| Equipment | day | 4 | 350 | 1,400 |
| IDW Disposal [2] | drum | 3 | 50 | 150 |
| Maintenance | lump sum | | | 750 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 64 | 65 | 4,160 |
| Car rental | day | 4 | 65 | 260 |
| Hotel | day | 8 | 100 | 800 |
| Expenses | day | 8 | 45 | 360 |
| Data Validation | lump sum | | | 2,500 |
| Reports | lump sum | | | 10,000 |
| Project Management at 10% | | | | 2,194 |
| | | | Subtotal | 24,134 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 4,827 |
| | | | **Total Annual Costs (year 2)** | **28,961** |
| **Annual O&M Costs (years 3 - 5)** | | | | |
| Analytical: (5 wells - annual) | | | | |
| VOCs [1] | number | 6 | 130 | 780 |
| Equipment | day | 2 | 350 | 700 |
| IDW Disposal [2] | drum | 2 | 50 | 100 |
| Maintenance | lump sum | | | 500 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 8 | 65 | 520 |
| Car rental | day | 2 | 65 | 130 |
| Hotel | day | 4 | 100 | 400 |
| Expenses | day | 4 | 45 | 180 |
| Data Validation | lump sum | | | 1,140 |
| Reports | lump sum | | | 5,000 |
| Project Management at 10% | | | | 945 |
| | | | Subtotal | 10,395 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 2,079 |
| | | | **Total Annual Costs (years 3 – 5)** | **12,474** |
| **Annual O&M Costs (years 6 - 20)** | | | | |
| Analytical: (5 wells - biannual) | | | | |
| VOCs [1] | number | 3 | 130 | 390 |
| Equipment | day | 1 | 350 | 350 |
| IDW Disposal [2] | drum | 1 | 50 | 50 |
| Maintenance | lump sum | | | 250 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 16 | 65 | 1,040 |
| Car rental | day | 1 | 65 | 65 |
| Hotel | day | 2 | 100 | 200 |
| Expenses | day | 2 | 45 | 90 |
| Data Validation | lump sum | | | 600 |
| Reports | lump sum | | | 2,500 |
| Project Management at 10% | | | | 554 |
| | | | Subtotal | 6,089 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 1,218 |
| | | | **Total Annual Costs (years 6 – 20)** | **7,306** |

Assumptions:
1. VOCs analysis includes an additional 20% for QA/QC samples
2. Low-flow purging and sampling assumed.

## Table F4-3
## 12 Area, Site 13 Groundwater
## Alternative 12A-2: Institutional Controls, Long-Term Groundwater Monitoring, and Product Removal
## Cumulative Cost

| Year | Annual O&M ($) | Capital ($) | Cumulative Cost ($) |
|---|---|---|---|
| 0 | 0 | 96,134 | 96,134 |
| 1 | 52,232 | 0 | 148,367 |
| 2 | 28,961 | 0 | 177,328 |
| 3 | 12,474 | 0 | 189,802 |
| 4 | 12,474 | 0 | 202,276 |
| 5 | 12,474 | 0 | 214,750 |
| 6 | 7,306 | 0 | 222,056 |
| 7 | 7,306 | 0 | 229,362 |
| 8 | 7,306 | 0 | 236,668 |
| 9 | 7,306 | 0 | 243,974 |
| 10 | 7,306 | 0 | 251,281 |
| 11 | 7,306 | 0 | 258,587 |
| 12 | 7,306 | 0 | 265,893 |
| 13 | 7,306 | 0 | 273,199 |
| 14 | 7,306 | 0 | 280,505 |
| 15 | 7,306 | 0 | 287,812 |
| 16 | 7,306 | 0 | 295,118 |
| 17 | 7,306 | 0 | 302,424 |
| 18 | 7,306 | 0 | 309,730 |
| 19 | 7,306 | 0 | 317,036 |
| 20 | 7,306 | 0 | 324,343 |
| | | **Total** | **324,343** |

## Table F4-4
## 12 Area, Site 13 Groundwater
## Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2
## Total Estimated Costs

| | Unit | Quantity | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Capital Cost** | | | | |
| Work Plan (SAP, QAPP, HSP, LTMP) | lump sum | | | 10,000 |
| Navy/Agency Comments/Meetings | lump sum | | | 10,000 |
| Project Management at 10% | | | | 2,000 |
| | | | Subtotal | 22,000 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 4,400 |
| | | | **Total Capital Cost** | **26,400** |
| **Baseline Sampling Costs (year 1)** | | | | |
| Costs include Alternative 2 Baseline Sampling Costs (year 1) with the addition of the following: | | | | |
| Analytical: (15 existing - semiannual) | | | | |
| Geochemical Analysis | number | 30 | 290 | 8,700 |
| Project Management at 10% | | | | 870 |
| | | | Subtotal | 9,570 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 1,914 |
| | | | **Total Baseline Sampling Costs (year 1)** | **11,484** |
| **Annual O&M Costs (year 2)** | | | | |
| Analytical: (4 + wells from Alternative 2 - semiannual) | | | | |
| VOCs [1] | number | 10 | 130 | 1,300 |
| Geochemical Analyses | number | 18 | 290 | 5,220 |
| Equipment | day | 3 | 350 | 1,050 |
| IDW Disposal[2] | drum | 3 | 50 | 150 |
| Maintenance | lump sum | | | 750 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 48 | 65 | 3,120 |
| Car rental | day | 3 | 65 | 195 |
| Hotel | day | 6 | 100 | 600 |
| Expenses | day | 6 | 45 | 270 |
| Data Validation | lump sum | | | 2,000 |
| Reports | lump sum | | | 9,000 |
| Project Management at 10% | | | | 2,366 |
| | | | Subtotal | 26,021 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 5,204 |
| | | | **Total Annual Costs (year 2)** | **31,225** |

## Table F4-4
## 12 Area, Site 13 Groundwater
## Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2
## Total Estimated Costs

| | Unit | Quantity | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Annual O&M Costs (years 3 - 5)** | | | | |
| Analytical: (4 + wells from Alternative 2 - annual) | | | | |
| VOCs [1] | number | 5 | 130 | 650 |
| Geochemical Analyses | number | 9 | 290 | 2,610 |
| Equipment | day | 2 | 350 | 700 |
| IDW Disposal[2] | drum | 2 | 50 | 100 |
| Maintenance | lump sum | | | 500 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 32 | 65 | 2,080 |
| Car rental | day | 2 | 65 | 130 |
| Hotel | day | 4 | 100 | 400 |
| Expenses | day | 4 | 45 | 180 |
| Data Validation | lump sum | | | 1,000 |
| Reports | lump sum | | | 4,500 |
| Project Management at 10% | | | | 1,285 |
| | | | Subtotal | 14,135 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 2,827 |
| | | | **Total Annual Costs (years 3 – 5)** | **16,962** |
| **Annual O&M Costs (years 6 - 10)** | | | | |
| Analytical: (7 wells - every 3 years) | | | | |
| VOCs [1] | number | 3 | 130 | 390 |
| Geochemical Analyses | number | 2.3 | 290 | 677 |
| Equipment | day | 1 | 350 | 350 |
| IDW Disposal[2] | drum | 1 | 50 | 50 |
| Maintenance | lump sum | | | 250 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 16 | 65 | 1,040 |
| Car rental | day | 1 | 65 | 65 |
| Hotel | day | 2 | 100 | 200 |
| Expenses | day | 2 | 45 | 90 |
| Data Validation | lump sum | | | 600 |
| Reports | lump sum | | | 2,000 |
| Project Management at 10% | | | | 571 |
| | | | Subtotal | 6,283 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 1,257 |
| | | | **Total Annual Costs (years 6 – 10)** | **7,539** |

## Table F4-4
## 12 Area, Site 13 Groundwater
## Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2
## Total Estimated Costs

| | Unit | Quantity | Unit Price ($) | Cost ($) |
|---|---|---|---|---|
| **Annual O&M Costs (years 11- 20)** | | | | |
| Analytical: (5 wells - every 6 years) | | | | |
| VOCs [1] | number | 1 | 130 | 130 |
| Geochemical Analyses | number | 0.8 | 290 | 242 |
| Equipment | day | 1 | 350 | 350 |
| IDW Disposal[2] | drum | 1 | 50 | 50 |
| Maintenance | lump sum | | | 250 |
| Labor/ODCs | | | | |
| Time (technician) | hour | 16 | 65 | 1,040 |
| Car rental | day | 1 | 65 | 65 |
| Hotel | day | 2 | 100 | 200 |
| Expenses | day | 2 | 45 | 90 |
| Data Validation | lump sum | | | 600 |
| Reports | lump sum | | | 2,000 |
| Project Management at 10% | | | | 502 |
| | | | Subtotal | 5,518 |
| | | | Contingency @ 20 percent (bid [10%];scope [10%]) | 1,104 |
| | | | **Total Annual Costs (years 11 – 20)** | **6,622** |

Assumptions:

1. VOCs analysis includes an additional 20% for QA/QC samples.
2. Low-flow purging and sampling assumed.

## Table F4-5
## 12 Area, Site 13 Groundwater
## Alternative 12A-3: Monitored Natural Attenuation with Alternative 12A-2
## Cumulative Cost

| Year | Annual O&M ($) | Capital ($) | Cumulative Cost ($) |
|---|---|---|---|
| 0 | 0 | 122,534 | 122,534 |
| 1 | 63,716 | 0 | 186,251 |
| 2 | 60,185 | 0 | 246,436 |
| 3 | 29,436 | 0 | 275,872 |
| 4 | 29,436 | 0 | 305,308 |
| 5 | 29,436 | 0 | 334,744 |
| 6 | 7,539 | 0 | 342,284 |
| 7 | 7,539 | 0 | 349,823 |
| 8 | 7,539 | 0 | 357,362 |
| 9 | 7,539 | 0 | 364,902 |
| 10 | 7,539 | 0 | 372,441 |
| 11 | 6,622 | 0 | 379,063 |
| 12 | 6,622 | 0 | 385,685 |
| 13 | 6,622 | 0 | 392,307 |
| 14 | 6,622 | 0 | 398,929 |
| 15 | 6,622 | 0 | 405,551 |
| 16 | 6,622 | 0 | 412,173 |
| 17 | 6,622 | 0 | 418,795 |
| 18 | 6,622 | 0 | 425,417 |
| 19 | 6,622 | 0 | 432,039 |
| 20 | 6,622 | 0 | 438,661 |
| | | **Total** | **438,661** |

**DRAFT OPERABLE UNIT 5 FEASIBILITY STUDY**
**FOR SITES 1A-1, 21, 1111, AND 12 AREA, SITE 13**
**MARINE CORPS BASE CAMP PENDLETON, CALIFORNIA**

**RESPONSE TO COMMENTS FROM**

**THE DEPARTMENT OF TOXIC SUBSTANCES CONTROL**
**(RECEIVED 5 APRIL 2005)**

***[As discussed during the FFA meeting held 24 May 2005, comments and responses relating to Site 21 have been removed from this document and will be addressed separately in a Technical Meeting and included in a separate report for Site 21. Section numbers in the responses to comments on Site 1111 and 12 Area, Site 13 reflect the section numbers of the draft final document. The remaining comments have been sequentially numbered to facilitate discussion.]***

**SPECIFIC COMMENTS**

**Comment 1: Section 1, Introduction:** Include acknowledgment in the document that Site 6A is part of OU 5; however, the site is not evaluated in the FS because the site was recommended for NFA based on the results of remedial investigation

> **Response:** Section 1.0 and the executive summary have been revised to acknowledge that Site 6A is part of OU 5 but was not evaluated in the FS because it was recommended for NFA based on the results of the remedial investigation.

**Comment 2:** The report describes the detection limits of 0.5 micrograms per liter (µg/L) for volatile organic compounds (VOCs) as background value The Navy may propose cleanup goals as the lowest detection limits; however, detection limits are not background levels. The statement is not consistent with detection limits for purposes of reporting (DLRs) for VOCs promulgated under California Code of Regulations (CCR), Title 22, Division 4, Chapter 15, Article 5.5, section 64445.1. Please delete statements throughout the report regarding background levels for VOCs because the DLRs for some VOCs are lower than 0 5 µg/L

> **Response:** Section 1 5.2 of the FS report states that "...*although background levels of VOCs are essentially zero, a concentration of zero cannot be measured.*" This section also states that "... *a value of 0.5 microgram per liter (µg/L) is considered the background (or detectable) level of VOCs* <u>*for purposes*</u> *of evaluating groundwater remedial alternatives... rather than assuming a concentration of zero)* The value of 0 5 µg/L is not being proposed as a cleanup goal but rather as a reasonable assumption to simplify the evaluation of alternatives that cleanup to background for all VOCs. The text has been revised to clarify that background must be consistent with detection limits for purposes of reporting (DLRs) for VOCs promulgated under California Code of Regulations (CCR) Title 22, Division 4, Chapter 15, Article 5.5, and therefore, may be lower than 0.5 µg/L.

**Comment 3: Section 2.6.2.2, Alternative 1A1-2, Institutional Controls (ICs):** Please describe the mechanism that will be used to implement the ICs. The sites may

need to be legally surveyed or the Marine Corps needs to evaluate the use of permanent markers and submit the text of the ICs language that will be included in the Base Master Plan (BMP) or other mechanism for each site separately The restriction language should be concise and clearly spell what the site can be used for and the specific conduct that is prohibited along with the reason for the restriction In addition, please include revisions regarding Notification/Request for Concurrence whenever land use change is anticipated in order to allow sufficient time for regulatory review and amendment to remedy selection document. The ICs should include annual inspection of the remedy and submittal of annual reports to regulatory agencies. Also, CERCLA requires that a five year review be conducted at the sites to ensure long term protectiveness of the remedy. Thus, regulatory agencies may inspect the remedy annually and monitoring reports (annual & 5 year reports) must be subject to regulatory agencies approval (including inspections, annual, and 5-year reports of the ICs).

The ICs are considered a remedy in accordance with California Health and Safety Code Section 25316 and Section 25260. The Marine Corps needs to provide assurance that there are adequate checks and balances within the process to ensure adherence to the ICs as specified in the California Military Environmental Coordination Committee (CMECC) ICs protocol dated May 5, 1998 Please submit an Implementation Plan (IP) for the ICs for regulatory agencies review and concurrence Otherwise, DTSC may seek other mechanisms such as Memorandum of Agreement (MOA) allowed under the CMECC protocol to ensure our participation in the process and the long-term protectiveness of the remedy. Also, please evaluate the applicability of Title 22, Section 67391 1(e) (2) which includes alternative approaches for land use controls where it is not feasible to record Land Use Controls Please evaluate Comment #3 for all sites included in the FS.

**Response:** As stated in Section 2.6.2.2, implementation of ICs will be conducted according to Navy standard procedures presented in DON memo titled *Monitoring and Enforcement of Land Use Controls* (U.S. Navy, 2003). This document provides the specific items to be included in the ROD and RAP, including listing the parties responsible for enforcing the land use controls, and the CERCLA five-year reviews to assess the effectiveness of the remedy

**DTSC Response to Comment 3:** DTSC comment #3 requested details implementation plan (IP) for institutional controls at the sites that require institutional controls. The response completely ignored the comment and referred to Navy Standard procedures for monitoring land use control

Please submit the specific IP and title of individuals who will carry out procedures that will be followed. DTSC wants to ensure that there are adequate checks and balances within the process to ensure adherence to the institutional controls. If DTSC is not comfortable with the IP, we may not support remedies that entails ICs or we may require a Memorandum of Agreement to ensure our participation in the process

Please revise the text of the Feasibility Study and provide the details of the IP. Also, please read comment #3 and address the remaining issues raised in the comment.

**Response:** The DTSC document that is cited in the comment (the CMECC protocol dated May 5, 1998) states that the description of the ICs should be included in the Remedial Action Workplan, the Remedial Action Plan, or the Record of Decision. Similarly, the DON memo titled "Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions (2003)," states that LUCs should be specified in the ROD and Remedial Action Work Plan.

It is understood that if ICs are to be part of remedy at any of the sites, DTSC needs to feel comfortable that the ICs will be enforced and tracked. In the case of the OU 5 sites, the ICs that may be a condition of the alternatives would require that site groundwater is not used for drinking water (that is, ensure that a new well is not installed and used for drinking water). There are steps that can be taken by the Base to ensure that the IC is workable, such as inclusion in the GIS system, but ultimately the exact details of the IC would be spelled out in an implementation plan (IP) At the FS stage, we are looking for concurrence from the FFA Team on the concept of the ICs, with the understanding that the implementation details will be included in the IP and reviewed by all FFA Team members before actual implementation.

To more fully describe the above explanation, the response to comment #3 will be revised as follows:

As stated in Section 2.6.2.2, implementation of ICs will be conducted according to Navy standard procedures presented in DON memo titled Monitoring and Enforcement of Land Use Controls (U.S. Navy, 2003). This document provides the specific items to be included in the ROD or RAP, including listing the parties responsible for enforcing the land use controls, and the CERCLA five-year reviews to assess the effectiveness of the remedy. It is understood that the FFA Team will need to thoroughly review and agree to the details of IC implementation, including specific restriction language, what system will be used to keep the ICs, how they will be triggered, the people responsible for tracking the ICs, and Base procedure language that specifies that land use changes need to be approved by knowledgeable personnel, among many other detailed requirements. It is proposed that all these detailed implementation procedures be contained in a Land Use Control (LUC) implementation plan (LUCIP), which will likely be attached to the ROD The IP will be subject to review and discussion by the FFA Team. Based on the direction provided in these memos, it is not appropriate to prepare the IP for LUCs as part of the FS.

Selected text is re-printed below from the DON memo titled "Principles and Procedures for Specifying, Monitoring, and Enforcement of Land Use Controls and Other Post-ROD Actions (2003). Please also refer to the memo in its entirety for full discussion of LUC implementation.

> *"Records of Decision should document the remedy selection process and remedy decision in accordance with CERCLA and the NCP, as well as applicable and appropriate guidance, regulations, standards, criteria, and policy. With regard to LUCs, the ROD should describe the LUC objectives; explain why and for what purpose the LUCs are necessary, where they will be*

*necessary, and the entities responsible for implementing, monitoring, reporting on and enforcing the LUCs The ROD will refer to the RD or RAWP for implementation actions."*

The following additional text is taken from the DON LUC memo regarding specific measures that will be followed in implementing LUCs:

*"EPA and DON agree that the most efficient framework for specifying, implementing, monitoring, reporting on and enforcing LUCs is:*

- *a standard FFA for NPL sites,*
- *a clear, concise RoD with LUC objectives, and*
- *a RD or RAWP with LUC implementation actions*

*Relative to land use controls and institutional controls, the ROD shall:*

- *Describe the risk(s) necessitating the remedy including LUCs;*
- *Document risk exposure assumptions and reasonably anticipated land uses;*
- *Generally describe the LUC, the logic for its selection and any related deed restrictions/notifications;*
- *State the LUC performance objectives (See attachment (2) for examples of LUC performance objectives);*
- *List the parties responsible for implementing, monitoring, reporting on, and enforcement of the LUC;*
- *Provide a description of the area/property covered by the LUC (should include a map);*
- *Provide the expected duration of the LUCs; and*
- *Refer to the RD or RAWP for LUC implementation actions, since these details may need to be adjusted periodically based on site conditions and other factors (See attachment (2) for examples of LUC implementation actions)."*

*Regarding the Remedial Design (RD) or Remedial Action Work Plan (RAWP):*

- *The RD or RAWP will be provided as a primary document in accordance with the FFA.*

- *The RD or RAWP will describe short and long-term implementation actions and responsibilities for the actions in order to ensure long-term viability of the remedy which may include both LUCs (e.g., institutional controls) and an engineered portion (e.g., landfill caps, treatment systems) of the remedy. The term "implementation actions" includes all actions to implement, operate, maintain, and enforce the remedy. Depending on the LUC and site conditions, these actions can include:*

- *Conducting CERCLA five-year remedy reviews for the engineered remedies and/or LUCs.*

- *Conducting periodic monitoring or visual inspections of LUCs; frequency to be determined by site-specific conditions.*

- *Reporting inspection results.*

- *Notifying regulators prior to any changes in the risk, remedy or land use including any LUC failures with proposed corrective action.*

- *Including a map of the site where LUCs are to be implemented."*

**Comment 4: Table 2-1 and Table 4-1 Proposed Remediation Goals:** Please reference the PRGs date of publication and specify if the PRGs are for residential or industrial.

**Response:** The proposed RGs were derived in Appendix D and Tables 2-1 and 3-1 have been revised for clarity.

**Comment 5: Table 3-2 and Table 5-2 Institutional Controls and Long-Term Monitoring:** The proposed monitoring frequency every 3 years for year 6 to year 30 and every 6 years thereafter may not be enough to support data gathering for the CERCLA 5-year review report.

**Response:** Table 3-2 and monitoring frequency will be addressed in a separate document for Site 21.

Both Table 4-1 for Institutional Controls and Long-Term Monitoring and Table 4-2 for Monitored Natural Attenuation show a monitoring frequency that would provide 7 sampling events in the first five years and 2 to 3 sampling events in the next five years. This should be adequate to evaluate the effectiveness of the selected remedy. The text in Section 4.6.2.2 has been revised to include that the monitoring network and sampling frequency would be continually reevaluated and revised as needed in response to plume changes and to determine if additional data would be needed to support the CERCLA 5-year review.

**Comment 6: Table 5-3, 12 Area, Site 13 Summary of Detailed Analysis of Alternatives:** The human health evaluation should include land restrictions on deep basement excavation for Alternative 12A-2.

**Response:** The proposed remedial goals (RG) and potential land use restrictions for the remedial alternatives presented in the FS were based on the results of the risk assessment presented in the RI report (Parsons, 2004a). These results were summarized in Section 4.1.5 of the FS. Future domestic use of groundwater (e.g., drinking water) and volatilization of chemicals of potential concern (COPCs) from groundwater into a future building were the only two potentially completed exposure pathways (refer to Section I6.1.2 of the RI [Parsons, 2004a]). As discussed in Section I6.3 of the risk assessment (Parsons, 2004a) and summarized in the FS, risk and hazard estimates for hypothetical domestic groundwater users exceeded USEPA's (1991b) point of departure target risk level of $1 \times 10^{-6}$ and target hazard index (HI) of one. However, the results of a conservative screening-level risk assessment indicated that adverse health effects associated with groundwater-to-indoor air volatilization and inhalation by future indoor workers are not expected (refer to Appendix J of the RI [Parsons, 2004a]). This evaluation was based on a hypothetical slab-on-grade structure. A supplemental evaluation indicated the risks do not change when reported to one significant figure at $2 \times 10^{-6}$ ($1.7 \times 10^{-6}$ is listed in Table J-1 and it would be approximately $2.3 \times 10^{-6}$ with a basement). Therefore, this evaluation indicates that restrictions on deep excavations (e.g., construction of a building with a basement) are not necessary from the perspective of potential future vapor impacts from VOCs in groundwater.

Text has not been modified.

**Comment 7: Table F1-3, Site 1A-1, Alternative 1A-3; Capping and Institutional Controls:** Add the cost of institutional controls for this alternative.

**Response:** The IC capital cost of $75,000 has been added to Alternative 1A1-3. The IC O&M cost for Alternative 1A1-3 is already built into the O&M costs for this alternative and therefore has not been added.

**Comment 8: Table F1-4, Site 1A-1 Excavation, Soil Pre-treatment, Backfill, and Off-Base Disposal, Cost Estimate:** Revise the foot note to include testing contaminated soil for total metal analysis. A total metals analysis is first performed to determine if a sample is hazardous by exceeding the corresponding Total Threshold Limit Concentration (TTLC) listed in Table II, Title 22, CCR. If the concentrations are above the TTLC the soil is considered a California hazardous waste. If the value is less than TTLC but greater than 10 times the corresponding Soluble Threshold Limit Concentration (STLC) value, a Waste Extraction Test (WET) will be performed. If the concentration of a substance in the (WET) extract is greater than the corresponding STLC, then the waste is a California hazardous. If a sample contains concentrations greater than 10 times the STLC, a RCRA determination is required by conducting a Toxicity Characteristic Leaching Procedure (TCLP) test. The waste is considered a RCRA hazardous waste if the analysis results exceed the TCLP value.

**Response:** Table F1-4 footnote has been revised to indicate testing contaminated soil for metal analysis Note that total metal analyses are included in the proposed analytical program for Alternative 1A1-4 as shown in Table F1-5

**Comment 9: Table A4-1, Potential Federal Action-Specific ARARs:** The Point of Compliance (POC) ARAR for Site 21 does not appear in the ARARs table; however, the POC is evaluated for Site 21 on page A2-6 of Appendix A The POC ARAR will need to be deleted if the California Regional Water Quality Control Board does not approve the proposed remediation goals within the plume or at the POC

**Table A4-2, Potential State Action-Specific ARARs for Soil and Groundwater:** Please provide an evaluation for land use controls remedy and restrictions on groundwater uses. The State ARARs submitted on the OU 4 FS may be used for the evaluation.

**Response:** As previously noted, Site 21 will not be included in the OU 5 Draft Final FS because the FFA Team plans to decide if specific additional data is needed to complete the Site 21 FS. For Site 21, DON and the FFA Team will ultimately reach agreement on remedial goals for the site during the time needed to perform additional technical data gathering. Please refer to Response to RWQCB Comment 5.

Table A4-2 has been revised to include an evaluation of land use controls remedies and restrictions on groundwater uses.

For additional comments on the Human Health and Ecological Risk Assessment, please see the enclosed comments from DTSC's Toxicologist, Dr. Riz A. Sarmiento, and Ms. Vicki Lake from the California Department of Fish and Game.

***[The following text/comments were provided by Riz A. Sarmiento, Ph.D. in a letter to Tayseer Mahmoud, dated March 18, 2005.]***

**DOCUMENT REVIEWED**

The Human and Ecological Risk Division (HERD) reviewed the Draft Feasibility Study for Operable Unit (OU) 5, with the primary focus on the development of human health risk-based preliminary remediation goals (PRGs) The document was prepared by Parsons, located in Pasadena, California The document was dated January 24, 2005

**SCOPE OF REVIEW**

These comments from HERD are primarily limited to its review of the sections in the document that pertain to the human health risk assessment. We assume that regional personnel have evaluated the evaluation of remedial alternatives and the costs associated with the different alternatives Any future changes or additions to the document should be clearly identified.

**BACKGROUND**

This document addresses (a) Site 1A-1 – Refuse Disposal Area adjacent to Site 1A, (b) Site 21 – Former Fuel Dock Facility, (c) Site 1111 – Burn Ash and refuse Disposal Area, and (d) 12 Area, Site 13 – Former Mess Hall and UST This document discusses four proposed remedial alternatives for each site, namely, (1) no action, (2) institutional controls, (3) capping with an engineered soil cover, along with cap monitoring/maintenance and institutional controls, and (4) soil excavation, backfill, pretreatment, and off-base disposal. Remedial goals were developed to evaluate the remedial alternatives for the OU 5 sites with soil contamination.

**GENERAL COMMENTS**

***[The following general comments have been sequentially numbered to facilitate discussion.]***

**Comment 10:** HERD's comments on the methodology for evaluating lead in the soil should be addressed in all the sites where lead was a chemical of potential concern. The document consistently applied the level of 3,500 mg/kg as the point of comparison for determining whether or not lead should be remediated. As indicated in the following specific comments, either the Region 9 PRG for lead or the USEPA Adult Lead Model should be used to evaluate lead

> **Response:** Refer to the response to Comment 12, below.
>
> **DTSC Response to Comment 10:** HERD's comments were addressed adequately. Any reference to an occupational soil preliminary remediation goal (PRG) of 3,500 will be deleted in the revised FS HERD recognizes that this change does not affect the remedial goal for lead because the proposed remedial goal is based on an ecological endpoint.
>
> **Response:** Comment noted; no further response necessary

**Comment 11:** For future submittals, HERD recommends that the methodology for calculating the remedial goals be more streamlined. The Tables in Appendix D currently show a PRG calculated for each exposure pathway based on a target exposure-specific risk of 1E-06. These three different PRGs are then readjusted to calculate a combined PRG that presumably results in a cumulative target risk of 1E-06. A more efficient methodology is to back-calculate a PRG based on a cumulative target risk of 1E-06 by using the spreadsheet that was used to calculate the predicted risk estimate (forward calculations) Through this process, the estimated risks associated with each exposure pathway to the back-calculated or developed PRG are already evident In addition to providing a more expedited review process, this approach reduces the number of steps and the possibility of calculation errors Unless one of the alternatives in the feasibility study is to mitigate potential exposures through a single pathway, it is irrelevant to present PRGs for each pathway. This recommended methodology is seemingly similar to the methodology presented for deriving the ecological remedial goals (Section E2 4) Other specific comments are listed below

> **Response:** The "ratio approach" used to calculate preliminary remedial goals (RGs) as described in Appendix D of the Draft FS is a simple, efficient method which ensures that the many input assumptions agreed upon and used in the RI (Parsons, 2004a) are incorporated into the preliminary RG calculations thereby minimizing the potential for input and calculation errors. The method used to combine route-specific preliminary RGs is consistent with the method used by USEPA Region IX (2004) in the development of their PRG table. Although the remedial alternatives are not necessarily designed to mitigate potential exposures through a single exposure pathway, route-specific preliminary RGs provide additional information and reviewers often request information on the primary exposure pathway of concern driving a particular remedial goal. However, HERD recommendations provided in this comment are acknowledged and will be considered for future submittals.
>
> **DTSC Response to Comment 11:** HERD does not agree that the "ratio approach", as it is applied in this document for calculating PRGs, is more efficient than the methodology that HERD recommended. At this point, the applied methodology will be deemed acceptable because these academic differences do not affect the proposed PRGs. HERD strongly suggests, however, that the recommended approach be applied in future submittals.
>
> **Response:** Comment noted; no further response necessary.

**SPECIFIC COMMENTS**

**Comment 12: Executive Summary, page iv:** Instead of using 3,500 mg/kg of lead for the occupational soil PRG, please use the USEPA Adult Lead Model or use the California EPA -modified PRG of 150 mg/kg (residential) and EPA Region 9 PRG of 800 mg/kg (industrial). Download the Adult Lead Model and User's Guidance from http://www.epa.gov/superfund/programs/lead/products.htm The Technical Review WorkGroup of USEPA re-analyzed data from NHANES and found that the correct geometric standard deviation for adult females in the western U.S. is 2 11 The DTSC LEADSPREAD model has used the same geometric standard deviation for adults and children, 1 60, which accounts for an enormous difference See http://www epa.gov/superfund/programs/lead/products/nhanes pdf

**Response:** Although it is true that the re-analysis of the NHANES data (after combining Phase 1 and 2 data) indicated an increase in the geometric standard deviation (GSD) of the background blood lead concentration ($PbB_{adult\ 0}$) from 1.60 to 2.11, the authors of the re-analysis (USEPA, 2002) state that, "Decreases in estimates of GM PbBs *[geometric mean background blood lead concentrations]* observed between Phases 1 and 2 are offset by increases in the GSD *[geometric standard deviation]*. The net effect is that the ranges of Preliminary Remediation Goals (PRGs) calculated using the ALM *[adult lead model]* do not differ appreciably between the two phases."

As stated in the comment, LEADSPREAD7 is sensitive to the background blood lead GSD input parameter. However, simply changing GSD in LEADSPREAD7 without accounting for the corresponding decrease observed in the geometric mean background blood lead ($PbB_{adult,0}$) is not technically appropriate, particularly since as pointed out by USEPA in their re-analysis (2002), the net effect is that the range of PRGs do not differ appreciably. Text throughout the FS has been edited to: 1) delete any reference to the occupational-soil PRG of 3,500 derived using the Cal/EPA LEADSPREAD blood-lead model; 2) continue referencing the default industrial soil PRG range derived using USEPA's Adult Lead Model (1996b); 3) update the USEPA Adult Lead Model (1996b) default industrial soil PRG range of 700 to 1,500 mg/kg to 780 to 1,200 mg/kg based on USEPA's re-analysis (2002) and reported in the finalized Adult Lead Model technical guidance (USEPA, 2003); and 4) acknowledge that the lower end (780 mg/kg) of this updated range is consistent with USEPA Region 9's industrial soil PRG of 800 mg/kg (2004). Note that these edits do not affect the remedial goal at sites where lead was identified as a chemical of concern (COC) since the proposed remedial goal is based on an ecological endpoint. There is no effect on the volume of impacted soils.

References cited above:

USEPA. 2002. Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III). OSWER #9285.7-52. March

USEPA. 2003. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. EPA-540-R-03-001. FINAL. January.

**DTSC Response to Comment 12:** HERD's comments were addressed adequately. Any reference to an occupational soil preliminary remediation goal (PRG) of 3,500 will be deleted in the revised FS. HERD recognizes that this change does not affect the remedial goal for lead because the proposed remedial goal is based on an ecological endpoint.

**Response:** Comment noted; no further response necessary

**Comment 13: Section 2.1.5, 3rd paragraph, page 2-5:** See specific comment 1

**Response:** Please see response to Comment 12

**Comment 14: Table 2-1, Site 1A-1 Proposed Remediation Goals:** Please explain the source of the ERA Preliminary Remediation Goal (PRG) of 44 mg/kg for 2,3,7,8-TCDD by clarifying some of the information presented in Table 2-1. The first column shows 2,3,7,8-TCDD TEQ for birds or mammals but the scenario-specific soil concentrations lists values for other types of receptors, e.g., terrestrial vegetation, invertebrates, and mammals. In addition, please explain "No-Effect" versus "Effect". The ecological criteria are typically "No Observed Adverse Effect Level (NOAEL)" or "No Effect Level (NOEL)."

If, as stated in Table 2-1, the effect-based ERA PRG of 44 mg/kg is supposed to be the lowest of the ecological PRGs for any wildlife, then this is inconsistent with the discussion in Appendix E, Section E2.4 that states that the effect-based TRV indicates an upper-bound limit above which remediation might be unnecessary. Please explain why the no-effect-based TRV of 4.4 mg/kg was not selected as the ERA PRG. The same question applies for lead and zinc.

**Response:** The derivation of the ERA PRGs is described in Appendix E. As indicated in footnote "c," the ERA PRG values presented in Table 2-1 are the lowest of the ERA PRGs for any of the wildlife receptors based on an effect-based TRV. The indicated ERA PRG for the dioxins and furans is 44 nanograms 2,3,7,8-TCDD TEQ (for mammals) per kilogram soil (not milligrams per kilogram, as indicated in the comment), and was derived for the deer mouse; see the summary presented in Table 3-1 of Appendix E. The second column of Table 2-1 indicates a maximum 2,3,7,8-TCDD TEQ concentration (for humans) of 2700 ng/kg, as derived in Appendix I of the RI (the human-health risk assessment). Table 2-1 has been revised to indicate that the maximum concentration is a TEQ concentration for humans (referencing Appendix I and that the ERA PRG is a TEQ concentration for mammalian wildlife (referencing Appendix E).

It is unclear what is meant in the comment by "... the scenario-specific soil concentrations lists values for other types of receptors, e.g., terrestrial vegetation, invertebrates, and mammals" with respect to the referenced table, Table 2-1. Table 3-1 of Appendix E provides some ecological benchmark (PRG) values for plants and soil invertebrates for inorganic COCs. However, there are no benchmarks for plants or invertebrates for exposure-point concentrations that are expressed as TEQ concentrations for birds or mammals; hence, Table 3-1 of Appendix E indicates "no benchmark" for the plant and invertebrate receptors.

TRVs for ecological risk assessment are derived values that are not necessarily actual NOAEL or NOEL doses. That is, depending on the available data, a specific experimental dose might be modified through the use of uncertainty factors to produce a value assumed, but untested, to be equivalent to a NOAEL or NOEL dose. Use of the phrase "no-effect" is thought to be sufficiently informative to a reader to convey that the indicated value (e.g., a TRV or a hazard quotient [HQ]) is based on an absence of effect.

Use of the modifier "effect" conveys the information for a contrasting endpoint, that is, one associated with eliciting a toxicological response. TRVs can be derived based on Lowest Observed Adverse Effect Levels (LOAELs) or Lowest Observed Effect Levels (LOELs). However, as the reviewer is aware, the DTSC

requires the use of the Navy/USEPA Region 9 BTAG TRVs in assessing ecological risk for mammals and birds, and while the Low TRV values are derived as no-effect levels, the High TRV values are not lowest observed adverse effect levels. Describing these as "effect TRVs" or "effect HQs" is thought to be sufficiently descriptive and inclusive of TRVs that may, or may not, be based on the lowest effect level.

The comment misquotes the text. Section E2.4 of Appendix E states *"[t]he PRG derived using an effect-based TRV would indicate an upper-bound limit above which further remediation might be necessary, if the exposure-point concentration for the area were greater than the PRG value."*

The effect-based ERA PRG of 44 ng/kg is the lowest of the effect-based PRGs for the wildlife receptors. Referring to that value as the upper-bound limit was intended to mean that the value is the upper limit of a range of values bounded on the lower end by the no-effect PRG values. The no-effect PRGs for the small mammals (Pacific pocket mouse, deer mouse, and southern grasshopper mouse) range from 4.4 to 190 ng/kg and the effect-based PRGs range from 44 to 1900 ng/kg. (PRGs for the coyote are not mentioned here, because the Area-Use Factor for this widely ranging animal results in very high PRG values.) The 44 ng/kg value represents an exposure concentration above-which adverse effects might be expected (in a population of deer mice), that is, it is a threshold concentration for the onset of adverse effects.

As indicated in the Appendix E text, the rationale for selecting 44 ng/kg as the PRG for dioxins and furans is that if the maximum residual concentration is at or below the ecoPRG, then the exposure for a population of mobile receptors within that area would never be at concentrations greater than the PRG and the exposure-point concentration (e.g., the 95%UCL) would always be within an acceptable range of concentrations that would not result in effect-based HQ values greater than one.

**DTSC Response to Comment 14:**

**a)** HERD appreciates the clarification on the units, i.e., HERD's erroneous comment that the ERA PRG for the dioxins and furans is 44 milligrams per kilogram, rather than nanograms per kilogram.

**Response:** Comment noted; no further response necessary.

**b)** Not having reviewed the human health risk assessment in Appendix I of the RI, the basis for the human health risk-based PRG of 2700 ng/kg of TEQ concentration of dioxins is unclear. The residential soil PRG for 2,3,7,8-TCDD is 3.9E-06 mg/kg or 3.9 ng/kg. The ratio of 2700:3.9 is 692. If the residential soil PRG of 3.9 ng/kg is based on a target cancer risk of 1E-06, then the proposed PRG for 2,3,7,8-TCDD could result in a cancer risk of 6.92E-04. Please include a brief discussion on the basis for the proposed human health risk-based TEQ concentration for clarification.

**Response:** The HERD comment above, "...the human health risk-based PRG of 2700 ng/kg of TEQ concentrations of dioxins..." incorrectly reflects the

proposed preliminary remedial goal for 2,3,7,8-TCDD TEQ. Please note that: 1) the proposed 2,3,7,8-TCDD TEQ human-based remediation goal listed in Table 2-1 of the FS is 17 ng/kg (refer to the last column), not 2,700 ng/kg and was based on an industrial land use scenario (refer to Appendix D of the FS for further details); 2) the potential risk to a nonintrusive worker from 2,3,7,8-TCDD TEQ estimated in the risk assessment of the RI was 2E-04 (refer to Table 2-15 and Section 2.5 of the RI and Section 2.1.5 of the FS) Potential risks to a future resident at Site 1A-1 were not estimated as part of the baseline risk assessment for reasons discussed in the RI and summarized in the FS; and 3) as stated in Section D2 (Appendix D) of the FS, "Preliminary remediation goals (RGs) were also calculated for an unrestricted land use (Table D-2). Note that residential use of the site is not reasonably expected in the future, and therefore unrestricted land use is not a mandatory goal of cleanup for this site. However, the RGs that would achieve a residential exposure scenario are provided in this document because it is likely that they would be met if waste soils are removed as outlined in the remedial alternatives." An unrestricted land use PRG of 3.9 ng/kg for 2,3,7,8-TCDD TEQ (based on USEPA toxicity data) is listed in Table D-2 of the FS, which is consistent with the "residential soil PRG" mentioned in the comment.

**c)** HERD's comment stemmed from a lack of clarification on the term "scenario-specific soil concentrations" that was used in Table E3-1. It seems that the Navy's consultant is equally unclear on the meaning of this term. HERD is presuming that the Pacific Pocket Mouse, Deer Mouse, Southern Grasshopper Mouse, and Gray Fox are site-specific ecological receptors that were used to cull different ecological toxicity reference values (TRVs). If this is the case, HERD recommends that the term "scenario-specific" in Table E3-1 be changed to "Receptor-specific", thus, making it consistent with the title of the Table

**Response:** With respect to this specific comment "c," HERD appears to use "PRG" and "TRV" interchangeably, and incorrectly. See, for example, the third sentence of the third paragraph of HERD's second comment. The following points provide further clarification concerning Table E3-1:

i. The Pacific pocket mouse, deer mouse, Southern grasshopper mouse, and gray fox are site-specific receptors, in addition to terrestrial vegetation, soil invertebrates and microbial processes, and the four bird species.

ii. The OU 5 Remedial Investigation provided the derivation of no-effect-based and effect-based TRVs for mammals (and birds). The TRVs are chemical-specific values for a specific group of receptors; the TRVs are not receptor-specific values.

iii The title of Table E3-1 refers to "Receptor-specific Ecological Preliminary Remediation Goals" (receptor-specific ERA PRGs) Receptor-specific ERA PRGs are derived from receptor-specific exposure-parameter values and chemical-specific TRVs.

iv. As defined in footnote "d" of Table E3-1, "scenario-specific" refers to the different scenario features, that is, the AUF adjustment (which was not used in the Screening-Level ERA) and whether the PRG was derived using

receptor-specific exposure information and a no-effect TRV, or was derived using receptor-specific exposure information and an effect-based TRV.

v The body of Table E3-1 presents receptor-specific ERA PRGs grouped into scenarios: only "no-effect" scenarios are presented for terrestrial vegetation and for soil invertebrates and microbial processes, while "no-effect" and "effect" scenarios are presented for the each of the mammalian and avian receptors.

The above information should clarify any lingering issues raised in DTSC's comment #14.

**Comment 15: Section 4.1.5, page 4-6:** The lead concentrations in the mixed soil samples ranged from 0.7 to 19,000 mg/kg with a standard deviation of 1,700. Please discuss how the 95 percent UCL of 96 mg/kg was derived. Considering the range of detected concentrations, please clarify the distribution of the data and explain the methodology for calculating the 95% UCL.

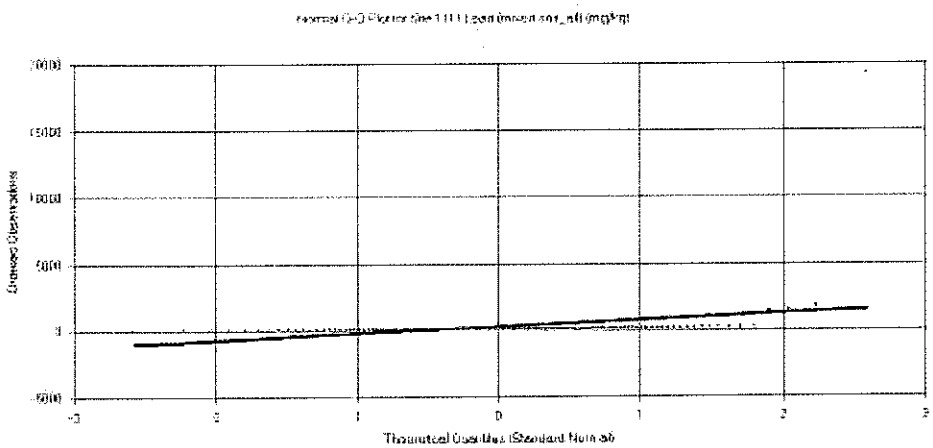
The site concentration of lead should be compared to either the industrial or residential soil PRGs established by EPA Region 9 (EPA, 2004) to the lead level developed by using the EPA Adult Lead Model (EPA, 2003)

**Response:** The surface and mixed soil 95% UCLs listed in Table I-14 of the RI report (Parsons, 2004a) were inadvertently misrepresented in the referenced text. The text has been corrected to read, "The 95-percent UCL surface (0 to 1.5 feet bgs) and mixed (0 to 10 feet bgs) soil exposure point concentrations of 110 and 380 mg/kg, respectively, are within the USEPA Adult Lead Model default industrial soil PRG range of 780 to 1,200 mg/kg based on USEPA's re-analysis (2002) and reported in the finalized Adult Lead Model technical guidance (USEPA, 2003). USEPA Region 9 conservatively used the lower end of this range when selecting an industrial soil screening PRG of 800 mg/kg (2004) Therefore, the lead 95-percent UCL in the mixed soil interval was 380 mg/kg, with concentrations ranging from 0 7 to 19,000 mg/kg

As discussed in Section I1.2.1.1 of the RI Report (Parsons, 2004a), the mixed soil 95-percent UCL of 380 mg/kg was calculated per the methods described in Appendix C of the Human Health Risk Assessment (HHRA) Protocol Document (Parsons, 2003a). The bootstrap method (Efron, 1981), a nonparametric method recommended by USEPA (1997b) for censored data, was used to calculate 95 percent UCLs on the arithmetic means. The details are not repeated here.

As shown in the following Q-Q probability plot of lead concentrations in Site 1111 mixed (0-10 feet bgs) soils, the maximum detected concentration of 19,000 mg/kg (1111MW-3) was an extreme outlier. Based on an evaluation of the spatial distribution of detected lead, this sample is likely representative of a very small volume of soil. The next highest concentration was 1,760 mg/kg (also detected at 1111MW-3). Removing the maximum detected concentration of 19,000 mg/kg from the dataset results in a 95-percent UCL of 81 mg/kg using the methods described in the HHRA Protocol Document (Parsons, 2003a).

Note that location 1111MW-3 lies within the area at Site 1111 with soils that have visual evidence of contamination, other contaminant concentrations above industrial PRGs, and likely will regulate remedial action per Section 3.1.3.1 of the FS and as shown on Figure 5-11 of Appendix B. As discussed in Section 3, one of the soil remedial action objectives is to address potential exposure to human and ecological receptors within this impacted area.



References cited above:

USEPA. 2003. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. EPA-540-R-03-001. FINAL. January.

**DTSC Response to Comment 15:** This comment was addressed adequately.

**Response:** Comment noted; no further response necessary

**Comment 16: Table 4-1:** Please refer to specific comment #3. The same comment applies on ERA PRGs for hexachlorobenzene, antimony, and mercury.

**Response:** Please see response to Comment 14

**DTSC Response to Comment 16:** This comment was not addressed

Clarification on the ERA PRGs for hexachlorobenzene, antimony, and mercury was not provided. Table E3-1, Appendix E, does not provide the supporting information.

**Response:** The response to Comment 16 directed the reader to response to Comment 14c. The response to Comment 14c provided applicable general information about the processes used to derive the ERA PRGs; however, the response to "Comment 16" should have also specifically referred to Table E4-5 as providing the supporting information for the ERA PRGs for hexachlorobenzene, antimony, and mercury, as derived for Site 1111.

The response to Comment 14 apparently created some uncertainty for the reviewer (see part "c" of Response to Comment 14 earlier in this document). The bullet items (listed earlier in this document as a response Comment 14c) provide a recap of technical points germane to the derivation of the ERA PRGs. As also stated previously after the bullet items, based on the series of communications, we respectfully request that HERD restate their concern(s), if concerns are still present, with the ERA PRGs derived in the OU 5 FS.

**DISCUSSION AND CONCLUSIONS**

**Comment 17:** This Draft Feasibility Study discusses the proposed remedial alternatives for Sites 1A-1, 21, 1111, and 12 Area, Site 13. HERD recommends a more concise and efficient methodology for calculating proposed remedial goals. In addition, HERD does not accept the use of 3,500 mg/kg as the acceptable concentration for an occupational scenario. HERD recommends using the residential or industrial soil PRGs established by EPA Region 9 (EPA, 2004) or the EPA Adult Lead Model (EPA, 2003). The document should also present additional discussion on the calculation of the 95% UCL, especially in areas where the distribution of the data indicates that there could be hot spots. HERD's comments on the apparent inconsistencies in the ecological remedial goals require some clarification

**Response:** Please see specific responses to comments.

**DTSC Response to Comment 17 (Discussion and Conclusions):** The Response to Comments failed to address specific comments 4 and 6. The remaining comments, however, were adequately addressed. The Feasibility Study for OU-5 will be deemed acceptable after HERD reviews and approves the responses to specific comments 4 and 6

**Response:** Comment 4 of the original comments was not addressed because Site 21 was removed from the Feasibility Study, as discussed during the FFA meeting held 24 May 2005 and as described at the top of Page 1 of these responses

With regard to Comment 6, please see specific response to Comment 16

***[The following text/comments were provided by the California Department of Fish and Game (Victoria Lake) in a letter to Tayseer Mahmoud, dated March 28, 2005]***

The Department of Fish and Game-Office of Spill Prevention and Response (DFG-OSPR) received the above-referenced document on February 15, 2005 DFG-OSPR previously reviewed the remedial investigation report (RI), Tier-1 screening-level ecological risk assessment, and Tier-2 baseline ecological risk assessment (BERA) for Operable Unit (OU) 5.

**BACKGROUND**

Camp Pendleton is an active military facility that occupies approximately 125,000 acres in the northwest corner of San Diego County. The Base has been conducting military training since World War II, and is the Marine Corps' primary amphibious training center. Aside from the nearly 10,000 acres that is developed, most of the base is largely undeveloped land that is used for training.

Camp Pendleton lies within the coastal Peninsular Range of southwestern California. The terrain of the base is varied, ranging from sandy shores and coastal plains to rolling hills, major stream systems, and mountains Habitat types include beach and dune communities; shrublands such as sage scrub, chaparral, and bluff scrub; riparian; grasslands; oak woodlands; and coastal salt marsh. Special-status wildlife species that occur at Camp Pendleton include 14 federally listed threatened or endangered species, 5 state-listed threatened and endangered species, 1 species both federally- and state-listed, and over 55 state-listed Species of Special Concern. Special-status plants include 3 species both state and federally listed as endangered, 1 species federally threatened, and 18 species considered rare but having no official listing status.

Operable Unit (OU) 5 sites are concentrated in the southeastern part of Camp Pendleton in the vicinity of Vandegrift Boulevard. Site 1A-1, the refuse disposal area adjacent to Site 1A, and Site 1111, a burn ash and refuse disposal area, are characterized by contaminants in soils at levels that may pose risks to ecological receptors Contaminants present in soils are primarily metals, dioxins, pesticides, and volatile organic compounds (VOCs).

Site 1A-1 is a debris disposal area approximately 1 5 acres It is located within the known foraging area of nesting Coastal California Gnatcatchers, which is federally listed as threatened and a California species of concern The site is also within the ecologically sensitive floodplain area of Pilgrim Creek. Four chemicals are present in soil at concentrations that are predicted to pose a potentially significant hazard to ecological receptors: antimony (invertivorous birds), lead (invertivorous and omnivorous birds), zinc (insectivorous birds), and dioxins (birds and small mammals)

Site 1111 has habitat suitable for the state- and federally-threatened Least Bell's Vireo The habitat is also suitable for the southwestern arroyo toad, which is federally-listed as endangered and a California species of concern Four chemicals are present in soil at concentrations that may pose a potentially significant hazard to ecological receptors: antimony (birds and small mammals), mercury (herbivorous and omnivorous small mammals), dioxins (herbivorous and omnivorous small mammals), and hexachlorobenzene (omnivorous small mammals).

The review conducted by DFG-OSPR focused on biological resource and ecological risk considerations as part of our role as a natural resource trustee for the State of California

**SPECIFIC COMMENTS**

**Comment 18: Site 1111, Section ES.3 and Section 4.1.1 Site Description and History**. The correct listing status for the Least Bell's Vireo is endangered under both the state and federal Endangered Species Acts In addition, the arroyo toad is federally listed as endangered and considered a California species of concern

> **Response:** The description of the listing status for these species has been corrected in the Draft Final

**Comment 19: Site 1A1, Section 2.1.2.5 Ecology**. A reference is cited for a biological assessment conducted for Site 1A1 (IT, 1999). This reference, however, is not listed in the References section. Please provide a copy of the biological assessment so that it can be reviewed for its completeness and adequacy.

> **Response:** The reference list has been updated for the Draft Final; the citation is provided below. A copy of the biological assessment was provided to the CDF&G in 1999

> Reference cited:

> IT. 1999. Marine Corps Base Camp Pendleton, California, Biological Assessment for Sites 1A, 1D, 1DE, 1F, 2A, and 30 20 May.

**Comment 20: Site 1A1, Section 2.1.7 Summary of RI Conclusions and Section 2.6.2.3 Alternative 1A1-3.** As the project plan develops, please coordinate with both United States Fish and Wildlife Service (USFWS) and DFG to identify appropriate biological monitoring and mitigation measures for impacts to the Coastal California Gnatcatcher.

> **Response:** As plans for specific remedial actions are developed, Base biologists and remediation contractors will coordinate with the FFA Team and appropriate agencies to ensure that biological monitoring and mitigative measures are identified and implemented (if necessary), to protect the Coastal California Gnatcatcher

**Comment 21: Site 1A1, Section 2.4.3 Containment**. If a remedial action is selected that disturbs natural habitat, please provide the revegetation specifications in the project plan and submit to DFG-OSPR for review. The site should be revegetated to provide habitat suitable for the Coastal California Gnatcatcher Topsoil can be stockpiled during the excavation effort for this purpose If a shift in habitat type must occur to accommodate an engineered cap, the loss of special-status species habitat will require mitigation. Revegetation should be conducted using native plant species.

> **Response:** As plans for specific remedial actions develop, Base biologists and remediation contractors will develop a project plan that duly considers the potential disruption of existing habitat (through time and across an area) or the potential loss of existing habitat (and necessary mitigation), and natural or engineered restoration processes The project plan will be provided to DFG-

OSPR for review sufficiently prior to planned implementation, to ensure that any necessary modifications to the plan can be incorporated.

**Comment 22: Section A3.2.3 Biological Resources ARARs and Section A3.1.4 Biological Resources Conclusions.** In several places throughout the text it mentions that no threatened or endangered species have been observed at the site under study, except for the California Coastal Gnatcatcher at Site 1A-1. Please elaborate on the nature of the biological studies that have been completed. Site-specific focused surveys should be performed to identify all special-status species with potential to occur in the area, including those that are considered sensitive to the State. Information on special-status species with potential to occur in the area can be obtained from the DFG's California Natural Diversity Database (CNDDB) at http://www.dfg.ca.gov/whdab/html/cnddb.html. Please call (916) 324-3812 with regard to any requests for additional information about the CNDDB. The Camp Pendleton Integrated Resources Management Plan is another useful source of information.

**Response:** As an outcome of ongoing activities by Base biologists, the preparation of, and updates to, the Base's Integrated Natural Resource Management Plan and previous biological investigations, the Base believes that it is adequately understood which special-status species have a potential to occur in the site-specific areas.

As indicated in the response to Comment 20, Base biologists and remediation contractors will coordinate with the FFA Team and appropriate agencies to ensure that biological monitoring and mitigative measures are identified, and implemented (if necessary), to protect the special-status species that potentially occur in the site-specific areas.

**Comment 23: Table A3-2 Potential State Location –Specific ARARs.** This table represents an incomplete list of potential State location-specific ARARs. An updated list of DFG ARARs is enclosed. Please include these ARARs in Table A3-2.

**Response:** The updated list was reviewed. Requirements that may be pertinent to the OU 5 sites were included. Many that were not directly addressed to OU 5 sites, were less stringent than federal ARARs, or were not necessary guidance for the OU 5 sites were not included. The document has been updated and the revised Table A3-2 is attached.

## CONCLUSIONS

**Comment 24:** After reviewing the FS, we generally concur with the excavation and capping remedies proposed by the Navy. We support remedial measures that would reduce impacts to biological resources. Mitigation for habitat destruction that results from cleanup activities may be required of the Navy and should be coordinated with the U.S. Fish and Wildlife Service for review and comment. We request that the final FS be prepared to address the specific comments provided herein. We also request that future remedial activity and biological restoration be coordinated with DFG-OSPR because of the ecological sensitivity of the OU5 sites. If you have any questions or require further details, please contact Victoria Lake at (916) 324-9811, or via email (vlake@ospr.dfg.ca.gov).

**Response:** Comments and perspectives noted.

# NOTICE OF EXEMPTION

**To:** Office of Planning and Research
State Clearinghouse
P.O Box 3044, 1400 Tenth Street, Room 212
Sacramento, CA 95812-3044

**From:** Department of Toxic Substances Control
Site Mitigation and Brownfields Reuse Program
Office of Military Facilities
Southern Calilfornia Operations
5796 Corporate Avenue
Cypress, California 90630

**Project Title:** Area of Concern (AOC) - 170, Vandenberg Air Force Base (VAFB), Interim Remedial Action (IRA) Workplan pursuant to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

**Project Location – Specific:** Southern VAFB on Micro Road off Arguello Road

**Project Location – City:** Unincorporated, near Lompoc **Project Location – County:** Santa Barbara

**Description of Project:**

DRAFT

**Background:**

Building 488 (AOC -170) together with Buildings 488, 484, and 490 comprised the General Electric Radio Tracking Station (GERTS) for the Atlas weapons system and space boosters. A fire damaged the north wing of Building 488 on December 29, 1999 and a portion of the roof and interior flooring were destroyed. Soil and debris samples were collected in 2000, 2001, 2003, and 2004 to delineate the vertical and lateral extent of contamination. The analytical results indicated that PCBs, metals, SVOCs, total petroleum hydrocarbon (TPH), and dioxins/furans were present above residential soil Preliminary Remediation Goals (PRGs) and/or Background Threshold Values (BTVs).

The burned debris and contaminated surface soil were removed in 2001 and 2003 However, additional removal is needed to reach unrestricted use standards. The maximum concentration remaining in the soil include PCBs at ~~0.59~~ 69 ~~micrograms~~ milligrams per kilogram (~~µg~~ mg/kg), Benzo(a)pyrene at 51 3 mg/kg, TPH at 4,499 mg/kg, Antimony, Arsenic, Chromium, Copper, Iron, and Lead at ~~238~~ 318, 8.8, 470, ~~1,270~~ 761, 67,500, 2,780 mg/kg, respectively. The maximum detected concentrations of Dioxins/furans were 302 343 picograms per gram (pg/g). AOC – 170 does not contain shallow groundwater as the site is located on a ridge with shallow bedrock.

**Project Activities:**

An estimated ~~1,820~~ 2,240 tons of soil will be removed and the depth of the excavation is approximately one to three feet below ground surface. Also, an estimated ~~250~~ 10,200 tons of non-hazardous concrete rubble will be removed for the area AOC – 170 has been divided into 12 areas based on physical features and analytical results. Twenty-three confirmation sampling points will be used to confirm that contaminated soils have been removed and that site-specific cleanup goals have been achieved.

The cleanup goals for AOC -170 are be based upon residential soil PRGs or BTVs that have been validated on a site-specific risk basis by a state toxicologist. The TPH cleanup goals will be the Regional Water Quality Control Board action levels of 100 mg/kg. If these values cannot be achieved, a separate approval will be required for additional work or revision of the cleanup up standards.

Personal air monitoring for worker safety and dust generation monitoring will be conducted by field staff to ensure compliance with Santa Barbara County Air Quality Management District (SBCAPCD) regulations The excavation project will comply with SBCAPCD best management practices for excavation of contaminated soil dig and haul projects. Thus, the project will meet the conditional exemption criteria and will not pose a health threat to the public Standard engineering/construction practices, such as water spray, will be used to control potential particulate emissions during excavation activities. The project will not produce offsite dust impacts and will also comply with Rule 302 (Visible Dust Emissions) and Rule 303 (Nuisance Emissions). The excavated soil will be loaded directly to trucks and areas of vehicle movement will be kept damp enough to prevent dust from leaving the site

Cal/EPA

Department of
Toxic Substances
Control

400 P Street,
4th Floor
P.O Box 806
Sacramento, CA
95812-0806

MEMORANDUM

Pete Wilson
Governor

Peter M. Rooney
Secretary for
Environmental
Protection

TO: Remedial Project Managers
Office of Military Facilities

FROM: Stan Phillippe
Division Chief
Office of Military Facilities

DATE: May 5, 1998

SUBJECT: INSTITUTIONAL CONTROLS AT OPEN MILITARY FACILITIES

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Recently the California Military Environmental Coordination Committee (CMECC) developed the enclosed Institutional Control Protocol (Protocol) for application at active military installations (attached). This Protocol is a consensus document that is intended to aid federal and state remedial project managers when incorporating institutional controls (IC) into response actions. You'll see it was signed by the Navy; however, as the Regional Environmental Coordinator for all the services in Region IX, the Navy represents the other service branches. All services were involved in the development of the Protocol.

IC are non-engineering mechanisms, particularly legal measures, designed to limit activities and/or access at a particular site. They are intended to protect the public and environment from residual hazardous substances during and after remediation, particularly where the cleanup level or containment remedies are not compatible with unrestricted land use. It will also expedite future reuse of the area by knowing what was the cause of concern and documenting the location. The Protocol discusses generally how to incorporate IC into a Removal Action Workplan (RAW), Remedial Action Plan (RAP) or Record of Decision (ROD) document, implementation mechanisms such as base master plans and memoranda of agreement, processes for changing IC, and verification mechanisms. This Protocol is consistent with the Department of Toxic Substances Control's Policy and Procedure (P&P) 87-14 and provides situational specific examples for the Department of Defense (DoD) facilities on how to implement IC at open bases. Since open bases have no deeds, traditional deed restrictions can not be used. You will need to work closely with your DoD counterpart and your management to determine the best way to implement the IC, verification methods, and long term assurances. The key elements of the Protocol and P&P 87-14 are as follows:

1) The RAW, RAP, or ROD document should identify the IC and explain why it is needed.

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2) Removal actions (Emergency removal, Engineering Evaluation/Cost Analysis, time critical removal, non-time critical removal) that have the foreseeable IC as part of the removal action will need to be memorialized in the final decision document, including a RAW, RAP, or ROD;

3) Memorializing the IC in the appropriate base document, such as a base master plan, that determines land uses, and provide the regulators with the verification of the implementation of the use restriction in a timely manner after the RAW, RAP, or ROD is signed;

4) Insuring the appropriate base document provides for regulatory review of any future land use changes for the area and a mechanism to resolve disputes over land use changes between DoD and the regulators. This appropriate base document should be used as the basis for land leases, land sales, transfers of land to other agencies (federal, state or local), or for the generation of Finding of Suitability to Transfer, Finding of Suitability to Lease, Environmental Baseline Study and/or land use covenant documents if the base closes;

5) The use of any IC triggers the Comprehensive Environmental Response, Compensation, and Liability Act 5-year review.

6) The Protocol calls for the use of physical monuments where appropriate. Where our project managers or others feel the risk or consequences of an inappropriate use warrant such measures, I encourage you to insist on them.

We are aware that Base Master Plans are not always considered. The military has also told us, since the protocol was signed, that the are other control points that should be used. For example, bases often require "Dig Permits" from public works offices for all excavation, even minor jobs. These offices are automating with GIS and could be an excellent check point to assure no-one is breeching a landfill cap to put in a new flagpole. Consider remedy language that would make ICs known to these offices.

DoD will be applying this Protocol at all active military installations where IC are expected to be part of the final remedy. You should use the CMECC document and P&P 87-14 as a guide and work closely with your DoD counterpart and your management to insure the IC are implemented and are effective over time.

If you have any general questions regarding the Protocol or P&P 87-14, please contact Shelia Lowe at (714) 484-5430 or Donn Diebert at (916) 255-3728.

Attachment

CALIFORNIA MILITARY ENVIRONMENTAL COORDINATION COMMITTEE

January 5, 1998

Remedial Project Managers:

The California Military Environmental Coordination Committee (CMECC) has developed the enclosed Institutional Control Protocol for application at active military installations. This protocol is a consensus document that is intended to aid federal and state remedial project managers when incorporating institutional controls into CERCLA response actions.

Institutional controls are non-engineering mechanisms, particularly legal measures, designed to limit activities or access at a particular site. They are intended to protect the public and environment from residual hazardous substances during and after remediation, particularly where the cleanup levels or containment remedies are not compatible with unrestricted land uses. The CMECC Protocol discusses how to incorporate institutional controls into decision documents, implementation mechanisms such as base master plans and memoranda of agreement, processes for changing institutional controls, and verification mechanisms.

If you have general questions regarding the document, please contact Ms. Shelia Lowe at (562)590-4856. Technical questions may be referred to members of the CMECC Cleanup Process Action Team members listed in the acknowledgments section.

Respectfully,

Stan Phillippe
Chief, Office of
Military Facilities
California Environmental
Protection Agency

Joe Ruzicska
Commander Naval Base
San Diego
United States Navy

for Dan Opalski
Federal Facilities Cleanup
Branch
United States Environmental
Protection Agency

Enclosure

# INSTITUTIONAL CONTROL PROTOCOL AT OPEN BASES

Prepared by
California Military Environmental Coordination Committee (CMECC)
Site Cleanup Performance Action Team

The purpose of this protocol is to provide guidance to project teams on the implementation of institutional controls at open military bases. This guidance represents a consensus approach developed by CMECC for application at open military bases in California.

Institutional controls are non-engineering mechanisms, particularly legal measures, designed to limit activities or access at a particular site. They are a type of CERCLA response action addressed in a Remedial Action Plan (RAP), Record of Decision (ROD) or other decision document. Typically, institutional controls are selected to prevent unacceptable risks to human health and the environment associated with residual contamination remaining at a site (e.g., land use restrictions or groundwater use restrictions), or they are selected to maintain the effectiveness of the remedy (e.g., restrictions to maintain the integrity of a landfill cap). They are designed to guarantee that the public and the environment are fully protected from residual hazardous substances during and after remediation, particularly where the cleanup levels or containment remedies are not compatible with unrestricted land uses.

At open DoD installations, institutional controls need to be implemented through the process for planning and approving changes to land use and related construction projects at the DoD installation. Typically, the Base Master Plan (BMP) is the best place to record the institutional controls so as to ensure their implementation by the DoD installation. The BMP establishes for the DoD installation land uses and similar "zoning-like" requirements and is utilized by the DoD installation for evaluating land use decisions and for project planning. However, before the BMP is selected as the document for recording the institutional controls, the DoD installation and regulatory agencies need to verify that the existing process at a DoD installation for land use planning and project approval does in fact include reference to the BMP and that there are adequate checks and balances within the process to ensure that there will be adherence to the institutional controls. Depending on the existing process at a DoD installation, it may be determined that a document other than the BMP is better suited for recording and implementing the institutional controls or that more than one planning document at the DoD installation needs to include the institutional controls.

Another option for implementing institutional controls at the DoD installation is through the establishment of a Memorandum of Agreement (MOA) between the DoD installation and the appropriate regulatory agencies. Such an MOA can be used instead of the BMP when it is determined that the BMP is not the appropriate vehicle for implementing the institutional controls, or it can be used as a supplement to the BMP or other planning document used to record the institutional controls.

The following institutional control protocol should be implemented at open DoD Installations:

1 Whenever institutional controls are determined to be necessary to protect human health or the environment, or to ensure the integrity of the remedy, the institutional controls should be included as a response action or part of a response action in a RAP or ROD document. In addition, a closeout or final RAP or ROD should be prepared whenever a removal action or interim remedial action that did not achieve unrestricted land use has been completed.

2. The RAP or ROD should include a description of the type of institutional control required and provide the reason for the restriction. The RAP or ROD should also identify specific conduct that is prohibited by the institutional control, including those specific land use changes that are prohibited as well as activities that are prohibited in order to preserve the effectiveness of the remedy.

3. As a component of implementing the institutional controls, the DoD installation and regulatory agencies should evaluate the use of permanent markers at the site of the institutional controls as another mechanism for ensuring adherence to the institutional controls. Such markers might include concrete landmarks containing a plaque describing the conduct prohibited by the institutional controls. Where DoD and the regulatory agencies agree to the use of permanent markers, the RAP or ROD should include permanent markers as part of the institutional controls. Additionally, the RAP or ROD may state that the use of such markers will be evaluated during the remedial design step.

4. Before finalizing the RAP or ROD where institutional controls will be required (preferably during the Feasibility Study), the DoD installation and regulatory agencies need to verify the effectiveness of the BMP for implementing the institutional controls at the DoD installation. Agreement needs to be reached as to whether the BMP, by itself or with another document(s), or some other documentation mechanism (e.g., an MOA) will be used to implement the institutional controls at the DoD installation.

5. The specific institutional control language that will be added to the BMP or other implementing document should include a description of the institutional control which clearly identifies the specific conduct that is prohibited by the institutional control, and it should include all of the requirements specified in the RAP or ROD for implementing the institutional control. Relevant hazardous substance site overlays and references to applicable Installation Restoration Program documents (e.g., RI/FS, ROD, etc.) should also be included in the BMP or other implementing document. The boundaries of the sites at the DoD installation subject to institutional controls should also be surveyed and recorded on appropriate base maps. Whenever feasible, the specific institutional control language that will be incorporated into the BMP or other implementing document should be included in the RAP or ROD. If not included in the RAP or ROD, the proposed institutional control language should be submitted to the regulatory agencies for approval prior to inclusion in the BMP or other implementing document. The RAP or ROD

should also include a requirement that the DoD installation record the institutional control in the BMP or other implementing document and provide the regulatory agencies with proof of such recordation within 6 months (or as otherwise agreed to) from signature of the ROD or RAP.

6. Changes to Land Use Post ROD or RAP:

6.a. Land Use Change Notification/Request for Concurrence: The RAP or ROD should include provisions addressing the following procedures and requirements:

(i) The DoD installation should provide timely notification to the regulatory agencies whenever the DoD installation anticipates any major change in land use (defined below in paragraph 6.c) for the site subject to institutional controls.

(ii) The DoD installation should notify the regulatory agencies as soon as a major land use change is anticipated in order to allow sufficient time for regulatory review and amendments to remedy selection decision documents (i.e., RODs or RAPs). Such notification should be made to the regulatory agencies at least 60 days prior to a major change in land use and should include:

1) an evaluation of whether the anticipated land use change will pose unacceptable risks to human health and the environment or negatively impact the effectiveness of the remedy;
2) an evaluation of the need for any additional remedial action resulting from the anticipated land use changes; and
3) a proposal for any necessary changes in the selected remedial action.

(iii) The regulatory agencies' review should address whether the anticipated land use change necessitates a modification to the selected remedy. The regulators should advise the DoD installation whether a ROD or RAP amendment or an Explanation of Significant Difference (ESD) document is required. The regulators should provide a written response within 30 days of the DoD installation's notification and request for concurrence, taking into account the need to minimize any adverse impact upon military operations.

6.b The ROD/RAP may include dispute resolution procedures or cross-reference to existing FFA/FFSRA dispute resolution procedures to address non-concurrence by the regulatory agencies on the DoD installation's Land Use Change Notice/Request for Concurrence discussed above in paragraph 6.a.

6.c. The following are considered major changes in land use:

(i) A change in land use classification that is inconsistent with the exposure assumptions in the risk assessment that was the basis for the institutional controls (either human health or ecological risk assessments). For example, the human health risk assessment assumed

that a site is in "caretaker" status with a worker visiting the site once a week for 2 hours, and the proposed change in land use would have a worker at the site for 8 hours a day, 5 days a week. Any change from industrial, commercial or recreational land use to a more sensitive land use such as housing, schools, hospitals and/or day-care centers is a major land use change. Similarly, any change from industrial or commercial land use to recreational land use is also a major land use change. Further, any change in land use that is prohibited in order to protect the environment is also a major land use change. For example, an area with residual contamination may be prohibited from being used for the creation of wetland habitat and the land use change would result in creation of a wetland

(ii) Any action that may disrupt the effectiveness of the remedial action. For example, excavation at a landfill, groundwater pumping that may impact a groundwater pump and treat system, or a construction project that may impact ecological habitat protected by the remedy.

(iii) Any other action that might alter or negate the need for the institutional control. For example, any plan to actively remediate a site subject to institutional controls in order to allow for unrestricted use.

7. The ROD or RAP should provide that the DoD installation will verify maintenance of the institutional controls through the CERCLA 5-year review process, and report "minor" land use changes (i.e., land use changes other than those defined above as "major" land use changes) to the regulatory agencies via the CERCLA 5-year review.

8. The ROD or RAP should provide that the DoD installation will notify regulatory agencies when any installation property subject to institutional controls is expected to be transferred, including federal to federal transfers. In the event a DoD installation subject to institutional control requirements is transferred, the institutional controls should be reviewed and incorporated as part of the FOSL and FOST procedures for leasing and transferring property at closing DoD installations. Any institutional controls in place at the time the property is transferred or leased should be set forth as restrictions on the property.

## ACKNOWLEDGMENTS

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