# 6. FEASIBILITY STUDY AND ALTERNATIVES ANALYSIS

This section presents: (1) the remedial technology screening matrix based on contaminated media, risk-based cleanup levels, and rough development grading requirements; (2) the criteria used to develop and evaluate remedial technologies; (3) the development of remedial action alternatives based on the screening and evaluation; and (4) assessment of remedial alternatives developed for OU-2 and rationale for selection of the preferred remedial approach.

## 6.1 Remedial Technology Screening

This section outlines the range of general response actions to address contamination at the Site and corresponding remedial technologies that are potentially applicable for the contaminated soil, soil vapor, and groundwater at the Site.

### 6.1.1 General Response Actions

A range of general response actions (GRAs), for which corresponding remedial technologies may be applicable to Site conditions, was identified for OU-2 for initial baseline evaluation and comparison purposes under RAP Guidance in Section 6.1.2. The GRAs considered for the Site include: no action, institutional controls, engineering controls, containment, ex situ treatment, in situ treatment, and excavation/disposal. Remedial technologies that correspond to the GRAs were then evaluated and compared based on three criteria: (1) effectiveness; (2) implementability; and (3) relative costs.

To refine the range of remedial technologies that would potentially be developed into remedial alternatives for the Site that must undergo detailed analysis, the NCP at 40 CFR §300.430(e)(7) provides the opportunity to initially screen them against the short- and long-term aspects of the following three criteria:

- Effectiveness: Alternatives are judged on the degree to which an alternative reduces toxicity, mobility, or volume through treatment, minimizes residual risks and affords long-term protection, complies with ARARs, and minimizes short-term impacts, and how quickly it achieves protection. Alternatives providing significantly less effectiveness than other, more promising alternatives may be eliminated. Alternatives that do not provide adequate protection of human health and the environment shall be eliminated from further consideration.
- Implementability: This criterion focuses on the technical feasibility and availability of the technologies each alternative would employ, and the administrative feasibility of implementing the alternative. Alternatives that are technically or administratively infeasible, or require equipment, specialists, or facilities that are not available within a reasonable period of time may be eliminated from further consideration.
- Cost: Costs of construction and any long-term costs to operate and maintain the alternatives shall be considered. Costs that are grossly excessive compared to the overall effectiveness of alternatives may be used as a factor to exclude alternatives from further consideration. Alternatives providing effectiveness and implementability

comparable to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may also be eliminated.

### 6.1.2 Remedial Technology Screening

This section describes the screening and selection of the range of remedial technologies that are potentially applicable for the contaminated soil, soil vapor, and groundwater at the Site. The Remedial Technology Screening Matrix presented in **Table 11** was used to guide whether a technology should be retained for further consideration based on the nature and extent of the current levels of contamination at the Site.

Land use restrictions (administrative/institutional mechanisms) would be included as components of the remedial action alternatives developed based on the remedial technology screening. These controls may be applicable both within the short term (e.g., to prevent reuse of groundwater or select vapor intrusion mitigation measures where there is significant risk or other controls until applicable CULs are achieved), and in the long term to: (1) maintain the reuses consistent with the risk exposures assumed in the development of CULs (or Site-specific CULs) for the preferred remedial actions; and (2) prevent unrestricted reuses of areas where residual contamination may remain.

The following technologies retained from the screening were then incorporated in the development of remedial action alternatives described in Section 6.2:

- Institutional Controls (administrative/institutional mechanisms) for Soil, Soil Vapor, and Groundwater – Restrictions limiting Site uses, such as limitations on use of groundwater without prior RWQCB approval, and adoption of land use restrictions (e.g., administrative controls and/or engineering controls) to ensure, for example, that occupied structures are protective of future site users and that engineering controls are monitored and maintained for the long-term protection of future site uses;
- Capping (containment) for Soils – Capping of existing Site soil using hardscape materials or a specified thickness of clean soil to ensure the protection of future Site users by eliminating direct contact exposure pathways to impacted soil;
- Excavation for Soils – Where development requires excavation or existing soil cannot be capped, excavation of soil exceeding CULs and offsite disposal, onsite ex situ treatment (see below) and/or excavation and relocation beneath a cap to eliminate direct contact exposure pathways and, in the case of offsite disposal, to reduce the amount of contaminant mass at the Site;
- Onsite Ex Situ Treatment for Soils – Ex situ smoldering to treat soils impacted with potentially mobile petroleum hydrocarbons, allowing for onsite reuse of treated soil;
- In Situ Treatment for Groundwater – Biological and/or chemical treatment to reduce the mass of residual CVOCs in groundwater with groundwater monitoring to evaluate effectiveness; and

- Monitored Natural Attenuation for Groundwater – Continued monitoring of the natural attenuation of VOCs in groundwater by sorption, dilution, biological transformation, and chemical reaction.

## 6.2 Remedial Alternatives Development and Evaluation

### 6.2.1 Description of Evaluation Criteria

The above technologies were assembled into four remedial alternatives which were subjected to: (1) a detailed alternative analysis pursuant to the nine criteria of the NCP and the six criteria of Section 25356.1 of the California HSC; and (2) comparative analysis identifying the advantages and disadvantages of each alternative when compared to other alternatives considered for the Site.

The nine NCP criteria include two threshold, five balancing, and two modifying criteria. For a remedial alternative to be considered an appropriate remedial action, it must meet both threshold criteria.

Balancing criteria provide an opportunity to identify and evaluate strengths, weaknesses, and the cost-effectiveness of an alternative. Modifying criteria are evaluated after the public comment period.

This section introduces these criteria. Summaries of the comparative evaluations of alternatives for the remedial action areas included in this DRAFT FS/RAP are presented in Section 6.4.

The California HSC requires that the remedial alternatives be evaluated relative to the following six additional criteria:

1. Health and safety risks posed by the Site conditions;
2. The effect of COCs present on probable present and future uses of contaminated or threatened resources;
3. The effect on available groundwater resources for present, future, and probable beneficial uses (treatment alternatives that reduce the volume, toxicity, and mobility of contaminants as opposed to alternatives that use offsite transport and disposal are preferred);
4. Site-specific conditions (potential for offsite migration) and existing contaminant background levels;
5. Cost-effectiveness, considering the short-term and long-term costs of the remedial action and whether deferral of a remedial action could result in a cost increase or hazard increase to human health or the environment; and
6. The potential environmental impacts of the remedial alternative such as land disposal of contaminated material versus treatment to remove or reduce its volume, toxicity, or mobility prior to disposal.

The six California HSC criteria are similar to and covered under the nine NCP criteria in this DRAFT FS/RAP described below.

*Threshold Criteria*

Overall Protection of Human Health and the Environment – Addresses whether a remedy provides adequate protection and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, or land use restrictions (i.e., administrative/institutional controls).

Compliance with ARARs – Addresses whether a remedy will meet all appropriate federal, state, and local environmental laws and regulations.

*Balancing Criteria*

Long-Term Effectiveness and Permanence – Considers the ability of a remedy to provide reliable protection of human health and the environment over time once cleanup goals have been achieved.

Reduction of Toxicity, Mobility, and Volume Through Treatment – Evaluates the anticipated performance of the alternative with respect to the reduction of toxicity, mobility, and volume of contaminants. This criterion reflects the preference for treatment of contaminated soil and groundwater as opposed to offsite transport and disposal.

Short-term Effectiveness – Evaluates the period of time needed to complete the remedy, and any adverse impact on human health and the environment that may be posed during the construction and implementation period, until cleanup standards are achieved. Potential impacts during construction include construction worker exposure to Site COCs, offsite dust migration, offsite stormwater and sediment migration, air pollution, and noise.

Implementability – Refers to the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a remedial option.

Cost – Evaluates the capital and O&M costs of each alternative for 30 years. Cost estimates of this type are considered accurate to a range of minus 30% to plus 50%. The reasons for this range are the variability of construction materials, variability in construction costs over time, the complexity of developing Site-specific cost factors, and the sensitivity of construction costs to economic factors such as interest rates and materials costs. All remediation costs are the responsibility of the Site owner or building owners.

*Modifying Criteria*

These criteria will be addressed during the public review and comment period on this DRAFT FS/RAP and will be summarized in the Responsiveness Summary to this DRAFT FS/RAP.

Regulatory Agency Acceptance – Indicates whether, based on their review of the information, the applicable regulatory agencies would agree with the preferred alternative.

Community Acceptance – The DRAFT FS/RAP is subject to public review and comment prior to selection of the remedial action alternative. This criterion assesses whether community concerns are addressed by the remedy, and whether the community prefers a remedy. The final remedies in this DRAFT FS/RAP will be selected following the public comment period.

## 6.3 Description of Remedial Action Alternatives

This section describes the remedial action alternatives that were developed based on assembly of the following applicable remedial technologies that passed the initial screening:

| |
|---|
| **Land Use Restrictions**<br>-- Land Use Covenant documenting the following prohibitions and requirements:<br>• No occupied buildings, including sensitive uses, where COC concentrations in soil vapor exceed CULs without RWQCB approval based on either (1) a risk assessment demonstrating Site soil vapor conditions pose no significant risk to human health based on a site-specific assessment; or (2) engineering controls, such as building design or vapor intrusion mitigation systems, that will reduce the risk of vapor intrusion to a protective level;<br>• No growing produce or vegetables for human consumption in native soil. Plants for human consumption may be grown if they are planted in raised beds (above the approved cover) containing non-native soil. Trees producing edible fruit (including trees producing edible nuts) may also be planted provided they are grown in containers with a bottom that prevents the roots from penetrating the native soil;<br>• No extraction or use of underlying groundwater is allowed without a Groundwater Management Plan pre-approved by RWQCB;<br>• No drilling for any water, oil, or gas, or extraction or removal of groundwater without a RWQCB-approved Groundwater Management Plan and prior written approval by RWQCB;<br>• No interference with, or modification of, a vapor mitigation system shall be permitted without prior written approval by RWQCB, and future tenants must provide reasonable access for O&M of vapor mitigation systems;<br>• All excavation into the cap shall comply with the RWQCB-approved Soil Management Plan (SMP);<br>• Contaminated soils brought to the surface by grading, excavation, trenching or backfilling shall be managed in accordance with all applicable provisions of state and federal law and a pre-approved RWQCB SMP;<br>• All uses and development of the Site shall preserve the integrity and effectiveness of the cap; and<br>• O&M Plan to maintain capped surfaces and operate vapor intrusion mitigation systems, if applicable. |
| **Engineering Controls**<br>-- Vapor intrusion mitigation systems or intrinsically safe building design for mitigating vapor intrusion into indoor air by VOCs in soil vapor;<br>-- Sub-slab venting. |
| **Capping**<br>-- Soil cover meeting soil import criteria for the Site with a minimum 5-foot thickness and an underlying demarcation layer; or<br>-- Hardscape consisting of concrete, asphalt, masonry or other durable, impervious surface; and<br>-- Building foundations. |
| **Excavation**<br>-- Where capping in place is not possible, soil exceeding CULs will be excavated to a depth of 5 feet, relocated onsite, and capped with a soil cover, hardscape, or building foundation;<br>-- Onsite treatment to satisfaction of soil import criteria and placement onsite;<br>-- Offsite disposal of excavated soil at a licensed and approved waste management facility. |
| **Onsite Ex Situ Soil Treatment**<br>-- Thermal/Smoldering to treat TPH in soil. |
| **In Situ Groundwater Treatment**<br>-- Biological and/or chemical treatment of CVOCs. |

**Monitored Natural Attenuation**
-- Groundwater monitoring to ensure COC concentrations decrease to CULs over time by natural processes including biodegradation, dispersion, and adsorption to soil.

The following Site-wide remedial action alternatives were developed based on the screening of remedial technologies presented in Section 6.1.2 and summarized in **Table 11**:

- Alternative 1: No Action;
- Alternative 2: Land Use Restrictions / Engineering Controls for Vapor Intrusion Mitigation / Monitored Natural Attenuation;
- Alternative 3: Land Use Restrictions / Engineering Controls for Vapor Intrusion Mitigation / Soil Capping / Excavation with Relocation and Containment / Excavation with Offsite Disposal / In Situ Groundwater Treatment and Monitoring; and
- Alternative 4: Land Use Restrictions / Engineering Controls for Vapor Intrusion Mitigation / Complete Excavation with Offsite Disposal and Restoration to Original Grade / In Situ Groundwater Treatment and Monitoring.

The alternatives are described below and comparatively evaluated in Section 6.4 based on the criteria presented in Section 6.2.

### 6.3.1 Alternative 1 — No Action

No additional control or protection of human health and the environment would be implemented for the contamination present at the Site. This alternative is required as a baseline alternative for comparison to other alternatives under RAP Guidance. There is negligible cost associated with administrative activities for this alternative.

### 6.3.2 Alternative 2 — Land Use Restrictions / Engineering Controls for Vapor Intrusion Mitigation / Monitored Natural Attenuation

This alternative assumes no active remediation would be implemented and risk exposures at the Site would be managed through land use and activity restrictions and engineering controls, which are described as follows:

**Land Use Restrictions**: Land use restrictions would be imposed to restrict certain land uses and activities and to require implementation and maintenance of engineering controls. The land use restrictions would prohibit the extraction or use of Fill groundwater for domestic and agricultural purposes without prior approval of the RWQCB. The land use restrictions would also require preparation and implementation of a Soil Management Plan approved by the RWQCB prior to excavation of soil. In areas where VOCs in soil vapor exceed CULs, vapor barriers and/or sub-slab venting systems would be incorporated into the designs of the buildings.

**Engineering Controls**: Engineering controls would be implemented to control dust emissions and stormwater runoff during construction and to mitigate intrusion of VOC vapors from the groundwater and soil into occupied buildings where needed. For costing purposes, monitoring of engineering controls to verify the vapor intrusion risk has been mitigated would be conducted for 30 years following construction.

**Monitored Natural Attenuation**: A groundwater monitoring program would be implemented to verify that natural attenuation of VOCs is occurring and concentrations of COCs in groundwater are decreasing over time.

A deed restriction would be recorded on the title to the property to document that Land Use Restrictions and engineering controls must remain in place to prevent human exposures to contaminants left in place in soil and groundwater above levels considered protective of unrestricted use of the Site, as described in Section 7.8.

The total estimated cost of this alternative is approximately $8.1 million, which includes capital costs of $1.2 million and O&M costs of $6.9 million over 30 years (**Appendix E**).

### 6.3.3 Alternative 3 — Land Use Restrictions / Engineering Controls for Vapor Intrusion Mitigation / Soil Capping / Excavation with Relocation and/or Offsite Disposal / In Situ Groundwater Treatment and Monitoring / Optional Ex Situ Soil Treatment

This alternative consists of the land use restrictions, engineering controls, and groundwater monitoring as described in Alternative 2 and, additionally, includes soil capping, excavation with relocation or offsite disposal, groundwater treatment, and a contingency for treating soil onsite. These additional elements are shown in **Figure 18** and summarized below:

**Soil Capping**: All exposed soil with residual COC concentrations above CULs at the Site would be capped with a minimum of 5 feet of imported clean fill (i.e., approximately 1,240,000 bulk cubic yards) or other hardscape material. Although not all soil exceeds CULs for unrestricted use, this alternative proposes to cap the entire Site. As described in the project description (Section 1.4), a significant amount of soil will be imported to the Site and placed as fill to raise the grade a minimum of 5 feet as part of site mitigation. In places, the ground elevation will be raised substantially as part of Site development. To meet the remedial action objectives of this Alternative 3 (i.e., to ensure the protection of future Site users by breaking the direct exposure pathway to impacted soil), the surface shall be capped with either hardscape material or the uppermost 5 feet of fill soil shall be composed of clean, imported soil. Soil imported as fill will meet the import criteria provided in **Appendix F**. Import soil criteria for capping purposes are consistent with, and in the case of arsenic more conservative than, the residential soil CULs in Section 4.2.1. A demarcation layer would be placed beneath the 5-foot thick soil cap to demarcate the transition between the clean soil cap and the underlying soil. A conceptual cross-section depicting the development is provided as **Figure 19**.

Soil in the western portion of the Site adjacent to Bayshore Boulevard with COCs that exceed health risk criteria will either be capped by hardscape (e.g., building foundations, paved areas) or excavated for onsite relocation beneath a clean soil cap or hardscape, offsite disposal, or onsite treatment and reuse or disposal. The excavations would be backfilled with clean soil so the thickness of clean soil is at least 5 feet over any residual soil with COC concentrations exceeding CULs.

Soil imported from offsite sources will be managed in accordance with a soil import plan to verify that it meets the soil use criteria for capping or other fill purposes. The soil import plan will be incorporated into a future RDIP.

**Excavation with Relocation and Capping or Off-haul**: Soil with COC concentrations exceeding CULs will be excavated and relocated onsite, treated, or transported offsite for disposal if capping is not appropriate or if capping is not possible due to the grading plan. For example, capping of soils within the CVOC-impacted area in Investigation Zones 4 and 6 would not address the vapor intrusion risk posed by the elevated concentrations of CVOCs in soil, so it is anticipated that this area will be excavated and disposed offsite unless treated. Based on available data, the excavation footprint within the CVOC-impacted area would be approximately 90 feet by 90 feet with a depth of 10 feet (i.e., approximately 3,000 bank cubic yards and assuming a 1.2 bulking factor). Other soil that may be excavated and disposed offsite includes PCB-contaminated soil, soil that is geotechnically unsuitable to support building foundations, or soil that exhibits strong visual and olfactory characteristics that are not desirable for the future development. For costing purposes, it was estimated that 10,000 bank cubic yards (i.e., 12,000 bulk cubic yards assuming a bulking factor of 1.2) of excavated soil would be transported offsite for disposal, with 80% (i.e., 9,600 bulk cubic yards) disposed as non-hazardous waste at the Class II facility in Altamont, California, and 20% (i.e., 2,400 bulk cubic yards) disposed as non-RCRA hazardous waste at the Class I facility in Buttonwillow, California. Other permitted disposal facilities may be used if appropriate. The off-haul volume of 12,000 bulk cubic yards corresponds to 1,000 truckloads of 12 cubic yards per load. Assuming an off-haul rate of 21 loads per day, off-haul would occur over approximately 48 days. Excavation and relocation/off-haul details will be specified in the RDIP.

Other impacted soil that could not be capped in place may be excavated and managed onsite, such as the area of the Site adjacent to Bayshore Boulevard where the Site grade cannot be abruptly raised by 5 feet or more. The Site boundary along Bayshore Boulevard is approximately 4,000 feet long. Assuming an average 10% incline, the ground surface elevation will rise by 5 feet at a distance of 50 feet east of Bayshore Boulevard. Within this 4,000 feet by 50 feet area, any existing soil with COCs that exceed the CULs and that will not be covered by hardscape will need to be excavated and backfilled. Assuming half of the area will be covered by hardscape and the other half will be excavated and backfilled, the area subject to excavation would be approximately 100,000 square feet. Further assuming a linear incline from 0 feet to 5 feet, the average thickness of clean fill within the excavation area would be 2.5 feet. Thus, to create a 5-foot-thick column of clean soil atop existing Site soil, the average excavation depth in this area would be 2.5 feet (i.e., the excavation depth is 0 feet where the thickness of clean fill is 5 feet, and the excavation depth is 5 feet where the thickness of clean fill is 0 feet). An excavation with area 100,000 square feet and thickness 2.5 feet has a volume of 250,000 cubic feet, or approximately 9,300 bank cubic yards.

For costing purposes, it was assumed that 10,000 bank cubic yards (12,000 bulk cubic yards) of excavated soil would be relocated onsite and appropriately capped with a clean soil cover, hardscape, or a building foundation. Details of excavation and relocation will be specified in a soil excavation and relocation RDIP.

**Groundwater Treatment**: Groundwater within the proposed treatment zone identified in **Figure 18** would be treated in situ using biological and/or chemical technologies (i.e., enhanced biological reduction, in situ chemical oxidation, and/or in situ chemical reduction). It is assumed that there will be two rounds of in situ treatment and that the cost for the second round will be approximately half the cost of the first round. Long term groundwater monitoring would also be performed to verify the effectiveness of the remedy. Details of the groundwater remedy and monitoring will be provided in the RDIP.

**Soil Treatment (Optional)**: The Revised RAP [B&M, 2002a] concluded that weathered Bunker C oil is effectively immobile in soil at typical Site temperatures. However, the potential for mobilization of weathered Bunker C oil in the Fill zone under the loads anticipated for soil capping and development cannot be evaluated in the absence of a specific site development plan. A pre-design petroleum mobility evaluation will be conducted to determine whether consolidation of the Fill zone will mobilize weathered Bunker C oil. A pre-design work plan will be provided to the RWQCB in advance of the evaluation and the results will be included in one or more RDIPs. If capping and site development is not appropriate, then as a contingency for limited application, onsite ex situ treatment of TPH-impacted soils using a thermal/smoldering technology may be implemented for treating soil containing potentially mobile Bunker C oil. For costing purposes, it was estimated that 12,000 bulk cubic yards of soil will be excavated, treated, and reused onsite.

The total estimated cost of this alternative without soil treatment is approximately $40.2 million, which includes capital costs of $33.3 million and O&M costs of $6.9 million over 30 years (**Appendix E**). If optional soil treatment is included, the cost for this alternative is $43.3 million, which includes capital costs of $36.4 million and O&M costs of $6.9 million over 30 years.

### 6.3.4 Alternative 4 – Land Use Restrictions, Engineering Controls for Vapor Intrusion Mitigation, Complete Excavation with Offsite Disposal and Restoration to Original Grade, and In Situ Groundwater Treatment and Monitoring

In this alternative, all soil with COC concentrations exceeding CULs would be excavated to the depth of either the top of a sample with all COC concentrations below screening levels or the maximum depth to groundwater, approximately 14 feet below ground surface. The estimated excavation depths across the Site are shown in **Figure 20**. All excavated soil would be transported offsite for disposal at a permitted waste management facility. For the cost estimate, it was assumed that 80% of the soil would be transported to the Class II facility in Altamont, California, and 20% of the soil would be transported to the Class I facility in Buttonwillow, California. Other approved disposal facilities may be used if appropriate. The off-haul volume of 694,000 bank cubic yards (833,069 bulk cubic yards, assuming a bulking factor of 1.2) corresponds to 69,400 truckloads of 12 cubic yards per load. Assuming a haul rate of 21 truckloads per day for six days per week, off-haul would occur over approximately 10.5 years. Following excavation, clean fill would be imported to the Site and placed in the excavations to bring the ground surface back to the existing grade. Imported soil would be placed and compacted to accommodate additional fill loads and building loads.

As in Alternative 3, groundwater within the proposed treatment zone identified in **Figure 18** would be treated in situ using biological and/or chemical technologies. It is assumed that there will be two rounds of in situ treatment and that the cost for the second round will be approximately half the cost of the first round. Long-term groundwater monitoring would also be performed to verify the effectiveness of the remedy. Details of the groundwater remedy and monitoring will be provided in the RDIP.

Soil vapor sampling will be conducted after regrading and prior to commencing vertical construction. If warranted by the soil vapor sample results, vapor intrusion mitigation will be included in future building construction and applicable land use restrictions will be implemented.

The total estimated cost associated with implementation of this alternative is approximately $201.5 million which includes capital costs of $194.6 million, and O&M costs of $6.9 million over 30 years (**Appendix E**).

## 6.4 Summary Evaluation and Comparative Analysis of Remedial Action Alternatives

The four remedial alternatives identified in Section 6.3 were assessed using seven of the nine NCP criteria for CERCLA sites established by USEPA [1989c] and additional California HSC criteria, as introduced in Section 6.2. The remaining two of the nine NCP "to be considered" criteria will be assessed after the DRAFT FS/RAP has been made available for public comment. A summary of the alternative evaluation and comparison is presented below.

For the evaluation of remedial alternatives, it was assumed that regrading will be completed in anticipation of redevelopment under all remedial alternatives. Regrading for redevelopment assumes soil will be imported to the Site to raise the grade according to the development plan. Thus, under all remedial alternatives, development activities will result in portions of the Site being covered with clean import soil and/or covered by hardscape. Only under remedial alternatives specifying soil capping will soil containing COCs at concentrations exceeding CULs be deliberately covered by a minimum 5-foot thick cap of clean soil and/or hardscape.

### 6.4.1 Threshold Criteria

*Overall Protection of Human Health and the Environment, and Compliance with ARARs*

Under Alternatives 1 and 2, portions of the Site would be capped with imported fill and/or covered with hardscape as part of the development grading plan, irrespective of the presence of COCs in soil. However, future Site users may come into contact with COCs in existing soil in uncapped areas. Thus, Alternatives 1 and 2 would not completely prevent exposure to Site COCs above CULs and would therefore not provide overall protection of human health and the environment nor comply with ARARs. For this reason, Alternatives 1 and 2 were not selected.

In contrast, Alternatives 3 and 4 would provide for excavation, land use restrictions, and vapor intrusion mitigation (if warranted), and Alternative 3 would provide for soil capping. In combination, the remedial technologies comprising Alternatives 3 and 4 would prevent exposures to COCs above CULs in soil, soil vapor, and groundwater. Therefore, these Alternatives would provide overall protection of human health and the environment as well as comply with ARARs, including Measure JJ (**Table 10**).

### 6.4.2 Balancing Criteria

*Reduction of Toxicity, Mobility, and Volume Through Treatment*

Alternatives 1 and 2 would not reduce the toxicity, mobility, or volume of contaminants in soil and groundwater through treatment and fail to satisfy this criterion. Although Site-specific treatment is only proposed as a contingency under Alternative 3, development activities including the placement of clean fill in a portion of the Site and construction of building foundations and roadways would reduce the mobility of contaminants in existing soil. However, for Alternatives 1 and 2, contaminant toxicity of mobility in soil or soil vapor would not be reduced in areas of the Site where neither raising the ground elevation nor construction are part of the redevelopment plan. In these areas, the risk levels identified in the HRA would be unmitigated during and following redevelopment.

In contrast, Alternatives 3 and 4 would reduce the mobility (e.g., potential wind dispersal and stormwater run-off) of COCs across the entire Site. Toxicity and volume of groundwater COCs in the CVOC Area (Zones 4 and 6) would be reduced through bioremediation. All existing Site soil would either be isolated beneath a cap of clean soil cover, or hardscape, or would be excavated and transferred to a permitted landfill. Additionally, Alternatives 3 and 4 would reduce the mobility and volume of contaminants in soil at the Site through excavation and offsite disposal. If needed, the optional treatment in Alternative 3 would further reduce the toxicity, mobility, and volume of contaminants in soil at the Site by thermal destruction of organic constituents such as TPH and VOCs. However, the toxicity of the off-hauled contaminated soil would not be reduced and would merely be transferred to a permitted landfill. The additional requirement for transport of impacted soil under Alternative 4 relative to Alternative 3 increases the risk of release due to the potential for surface street and highway-related accidents and impacts, loading and unloading activities, and potential releases from the landfill facility, should its containment become compromised. The transport of the impacted soil would also contribute to the emission of criteria air pollutants, other toxic air pollutants, and greenhouse gas emissions.

*Long-Term Effectiveness and Permanence*

Alternatives 1 and 2 would not effectively prevent exposures across the entire Site in the long-term, given the reasonably anticipated use of the Site, because no action would be taken to mitigate Site risks in areas where neither raising the ground elevation nor construction are part of the redevelopment plan.

Alternatives 3 and 4 would offer long-term effectiveness and permanence by addressing COCs in soil across the entire Site and in groundwater within the CVOC Area, implementing and maintaining land use restrictions, and preparing a soil management plan that would describe requirements for any potential contact with impacted soil or groundwater at the Site. Although Alternative 4 would offer long-term effectiveness for the Site, this Alternative would transfer a significant amount of contaminated soil to a landfill (i.e., approximately 69 times more than Alternative 3), where it would require management in perpetuity to prevent long-term impacts to the environment. It would also contribute to aggregate greenhouse gas loading.

*Short-Term Effectiveness*

Alternatives 1 and 2 would not be effective in the short term, given the reasonably anticipated use of the Site, because no action would be taken to mitigate Site risks in areas where neither raising the ground elevation nor construction are part of the redevelopment plan.

For Alternatives 3 and 4, the period of time needed to complete the remedy would be similar, though off-haul of excavated soil would be expected to take approximately 48 days for Alternative 3 and, assuming the same haul rate, approximately 10.5 years for Alternative 4. For Alternatives 3 and 4, short-term protectiveness would be provided by implementing measures to protect remedial construction workers, and through Occupational Safety and Health Administration work standards during excavation, relocation and capping, and offsite disposal.

Controls identified in pre-construction plans and implemented during construction would manage offsite dust migration and offsite storm water and sediment migration. Best practices will be implemented to minimize air pollution, and all construction activities involving heavy machinery will be conducted during typical working hours. Air pollution and noise impacts will be far greater for Alternative 4 than for Alternative 3 because of the more extensive earthwork in Alternative 4. Air pollution would be associated with heavy equipment excavating and handling soil, trucks to transport material offsite, trucks to transport soil back onsite to fill the excavation, and heavy equipment for placing and compacting fill soil back into the excavation.

The greenhouse gas emissions by excavators and loaders is roughly proportional to the quantity of soil being excavated and stockpiled. Thus, the greenhouse gases emitted during excavation and stockpiling of 833,000 bulk cubic yards of soil under Alternative 4 would be approximately 30 times greater than excavating and stockpiling 24,000 bulk cubic yards of soil under Alternative 3.

The impacts of soil transportation for Alternatives 3 and 4 were estimated using assumptions for OU-2 in the Draft Environmental Impact Report for the Brisbane Baylands [ESA, 2018]. The following emissions were calculated for Alternatives 3 and 4:

| Alternative | Off-haul of Excavated Soil | Import of Backfill or Cap Soil | TOTAL |
|---|---|---|---|
| 3 – Capping, limited excavation with partial onsite relocation and partial offsite disposal | 299 | 379 | 678 |
| 4 – Site-wide excavation and offsite disposal, backfilling to restore grade | 20,700 | 255 | 21,000 |
| 4* – Site-wide excavation and offsite disposal, backfilling, and regrading to 5 feet above current grade (same as Alternative 3) | 20,700 | 634 | 21,400 |

Notes: Units are metric tons of greenhouse gas emissions as carbon dioxide equivalents based on emission factors provided in Appendix G of the Draft Environmental Impact Report for the Brisbane Baylands [ESA, 2018]. Transport of excavated soil to Altamont Landfill (58 miles from the Site) and Buttonwillow Landfill (260 miles from the Site) were assumed for non-hazardous and hazardous soil, respectively; imported fill was assumed to be transported from the Baylands Soil Processing facility (1.25 miles from the Site). Tabulated quantities are for remediation only and do not include soil import and regrading for development.

The greenhouse gas emissions that would be generated transporting soil are approximately 31 times higher for Alternative 4 than for Alternative 3. The soil quantities for placement and compaction are slightly greater for Alternative 3 than for Alternative 4 (i.e., 1,240,000 bulk cubic yards and 833,000 bulk cubic yards, respectively), so greenhouse gas emissions for placement and compaction would be higher for Alternative 3 by approximately 50%. The higher greenhouse gas emissions associated with excavation, stockpiling, and transportation make Alternative 4 approximately 30 to 60 times more impactful than Alternative 3.

However, the Site grade following implementation of Alternative 3 would be five feet higher than current grade across most of the Site, whereas the Site grade would be unchanged following implementation of Alternative 4. Currently, the development plan consists of raising the grade over most of the Site by at least 5 feet and up to 30 feet. Comparing emissions for Alternatives 3 and 4 for the same post-remedial Site grading (i.e., approximately 5 feet higher than current grade across most of the Site), Alternative 4 would require backfilling the excavation and importing soil to raise the Site grade 5 feet, summarized as Alternative 4* above.

*Implementability*

Each Alternative is readily implementable from a technical and administrative feasibility perspective. Alternative 2 would be easier to implement from a technical perspective than Alternatives 3 and 4 because it only involves administrative action for implementing the land use restrictions, construction of vapor mitigation controls during redevelopment, if warranted, and groundwater and reporting. Alternative 3 and 4 by comparison require excavation and capping of soils and remediation of groundwater using bioremediation. Alternative 4 is implementable, but provides the highest overall risk and emissions to the environment due to waste hauling and offsite transfer of all excavated soil, and import and placement of fill soil. Significantly increased truck traffic would increase congestion on surface streets and highways and increase the likelihood of vehicular accidents.

*Cost*

Of the four remedial alternatives, Alternative 4 ($ 201.5 million) has the highest estimated cost (**Appendix E**).

### 6.4.3 Modifying Criteria

*Regulatory Agency and Community Acceptance*

Formal assessment of regulatory agency and community acceptance will be considered during the public comment period on this DRAFT FS/RAP, and documented in a Responsiveness Summary that will be included as part of the FINAL FS/RAP.

### 6.4.4 Additional HSC Criteria

Alternatives 1 and 2 do not meet several California HSC criteria for the entire Site, including the health and safety risks posed by contamination at the Site and the effect of contamination on future uses of the Site. Alternatives 3 and 4 would meet all California HSC criteria. Alternative 4 would result in the greatest offsite environmental impact due to hauling and transportation of all excavated soil to an offsite landfill facility.

## 6.5 Alternatives Screening Results

The comparative analysis of remedial alternatives discussed in the previous section is summarized in **Table 12**. Scores were assigned to each remedial alternative for each of the above criteria based on whether the alternative meets the criterion, mostly meets the criterion, partially meets the criterion, or does not meet the criterion.

Alternatives 1 and 2 are not adequately protective and scored low for threshold criteria and several balancing criteria. Alternatives 3 and 4 are similarly protective in that COCs in existing fill would be isolated beneath a cap and potential exposure pathways would be incomplete. Alternative 3 scored the highest based on (1) comparable protectiveness as compared with Alternative 4; and (2) the lowest environmental impact by virtue of off-hauling less soil than Alternative 4. Based on the comparative analysis of remedial alternatives, Alternative 3 was selected as the preferred alternative.