ADDENDUM
REMEDIAL INVESTIGATION / FEASIBILITY STUDY REPORT

Union Pacific Railroad Yard
Sacramento, California

Volume 1: Text, Tables, Figures

Prepared For

UNION PACIFIC RAILROAD COMPANY

By

DAMES & MOORE

NOVEMBER 1991

ADDENDUM
REMEDIAL INVESTIGATION / FEASIBILITY STUDY REPORT
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

DAMES & MOORE

November 1991
Job No. 00173-064-044

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November 1, 1991

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California Environmental Protection Agency
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Attention: Mr. James L. Tjosvold, Chief
Sacramento Responsible Party Unit
Site Mitigation Branch

RE: Addendum Remedial Investigation/
Feasibility Study Report
Union Pacific Railroad Yard
Sacramento, California
Job No. 00173-064-044

Dear Mr. Tjosvold:

Union Pacific Railroad Company (UPRR) has requested that Dames & Moore transmit the enclosed Addendum Remedial Investigation/Feasibility Study (RI/FS) Report for the UPRR Yard, Sacramento, California. The final RI/FS Report (Dames & Moore, May 1991) was approved by the DTSC in September 1991. This Addendum RI/FS Report is presented as a supplement to the final RI/FS Report to provide information on the results of soil and groundwater investigations conducted since the preparation of the draft RI/FS Report in August 1990, and to incorporate these data into a Revised Baseline Health Risk Assessment and a Supplementary Feasibility Study.

If you have any questions regarding the enclosed report, please contact Tim Parker of this office.

Sincerely,

DAMES & MOORE

Timothy K. Parker

Timothy K. Parker
Project Manager

Graeme W. Nyland

Graeme W. Nyland
Senior Engineering Geologist, C.E.G. #1616

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ADDENDUM REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT
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1.0 INTRODUCTION

Dames & Moore is pleased to present this Addendum Remedial Investigation/Feasibility Study (RI/FS) Report for the Union Pacific Railroad (UPRR) Yard, Sacramento, California (Figure 1). The purpose of this Addendum RI/FS Report (Addendum RI/FS) is to supplement the final RI/FS Report (Dames & Moore, 1991f) (RI/FS Report) with the additional soil and groundwater data generated since submittal of the draft RI/FS Report (Dames & Moore, 1990a) in August 1990. The draft RI/FS Report was finalized by the Department of Toxic Substances Control (DTSC) (formerly the Department of Health Services — DHS) in May 1991, with minimal modification. A summary of the data and interpretations presented in the RI/FS Report is provided in Section 3.0 of this Addendum.

Data not included in the RI/FS Report were data generated during the following additional soil and groundwater investigations which were conducted subsequent to submittal of the draft RI/FS Report in August 1990:

- Asbestos trenching activities, August-November 1990;
- Supplementary groundwater investigations, September-October 1990;
- Additional on-site groundwater investigations, February 1991;
- Additional off-site groundwater monitoring well installations, May 1991;
- Additional on-site soil and groundwater investigations, May-June 1991;
- Additional off-site soil investigations, May-July 1991; and
- Revisions to the baseline health risk assessment, August 1991.

Additionally, quarterly groundwater monitoring data for September 1990, January 1991, and April 1991 are incorporated into this Addendum. Some of these investigations were previously reported in the following documents:

- Proposed Cover and Summary of Activities, former Asbestos Storage Area, Dames & Moore, Letter to DTSC, November 15, 1990d; and

- Supplementary Groundwater Investigation Report, Dames & Moore, January 1991a.

The additional data were obtained to provide revised interpretations of the distribution of contaminants on- and off-site in soil and groundwater, and revised estimates of volumes of soil and groundwater requiring remedial action. The soil and groundwater operable units have necessarily been altered to incorporate the new data. Additional soil and groundwater alternatives evaluations have been completed only to the extent necessary to supplement previous work, with previous alternatives screening and detailed analysis not repeated but referenced to the RI/FS Report where appropriate.

2.0 SITE BACKGROUND

2.1 SITE DESCRIPTION

Previously, in the RI/FS Report, the site was described as encompassing an area of approximately 65 acres, and being securely fenced. The previous description of the site did not take into account the active portion of the railroad yard. The site has now been redefined as consisting of both the inactive portion of the former maintenance yard (previously "the site"), and the active portion of the railroad yard. The active portion of the site borders the inactive portion of the site to the west (Figure 2).

2.1.1 The Inactive Portion of the Site

The inactive eastern portion of the site is the area previously defined in the RI/FS Report as the "site". The inactive portion of the site encompasses an area of approximately 63 acres, and is securely fenced.

2.1.2 The Active Portion of the Site

The active western portion of the site consists of approximately 31 acres, and is the location of the UPRR main active line, and several other limited tracks which are used for railroad car switching. Also present in the active portion of the site is a Yard Office which is occupied daily by UPRR Sacramento operations staff. The active portion of the site is used only for switching and temporarily holding cars and not for any railroad maintenance activities.

2.2 SUPPLEMENTARY HISTORICAL EVALUATION

Previous historical information on the site presented in the RI/FS Report focused on the former railyard activities. Information provided in the previous assessment indicated that the railyard was established by Western Pacific Railroad (WPRR) in the early 1900s to maintain and rebuild steam locomotives and refurbish rail cars. Diesel engine repair and maintenance began in the mid 1950s. The site was purchased by UPRR in 1982, and maintenance operations were discontinued in 1983. Buildings and structures on the site were demolished in or before 1986.

A history of site operations of the yard facilities was compiled, based on historical records, aerial photographs, interviews with UPRR employees and UPRR drawings dating back to 1910. Using the site history, an understanding of potential hazardous materials usage at the former maintenance yard was developed. This information was utilized to generate a facility composite map (Figure 2).

Potential hazardous material usage included:

- Fuels and oils which were stored both in above and below ground tanks;
- Metals such as lead, copper, and arsenic which could have originated from sandblasting, herbicide use, painting, machining, welding activities, and babbitted bearing manufacture;
- Asbestos which was used in boilers and pipes of steam engines; and
- Solvents, cleaners, and degreasers which were used to clean and strip engine parts and cars in the maintenance facilities.

Hazardous material usage was concentrated in the southern portion of the former maintenance yard in the now inactive portion of the site.

A supplementary historical evaluation was conducted to more fully assess the past site land uses and development. The information, provided in the following sections, indicates the site was largely used for agricultural purposes for several decades prior to the construction of the railyard, and suggests additional potential sources for some of the site contamination.

2.2.1 Historical Land Development

The historical land development was generated on the basis of available historical documents including Tax Assessor's Plat Books, maps of Sacramento, and building records. Historically, the site area was subject to flooding and a portion of the area was classified as swamp and overflow lands under federal and state land laws. The site area was completely inundated by historic floods of 1862, 1878, and 1904, and was seasonally saturated by overflows that spread south from Burns Slough along the eastern edge of the city limits.

Improved drainage and construction of improved levees along the Sacramento and American Rivers in the late 1800s reduced the flood potential in the site area, increasing the desirability of land development, and the urban area of Sacramento spread to the south. Approximately 1890 or earlier, an east branch drainage canal was cut through the northern portion of the site. The east branch canal connected with a main drainage canal to the west, and was apparently designed to drain the farmlands between the City of Sacramento and Sutterville Road, as well as sewage of the early suburbs of the Oak Park area and other highlands in the vicinity. It appears that a portion of the east branch canal remains in the form of the curved drainage canal that runs north to the 114-inch combined storm-sewer line that crosses the site (Figure 3).

The site area supported a variety of agricultural land uses until approximately 1910 when the site area was annexed to the city. In 1908, WPRR accepted the citizen-donated land offer of a group of Sacramento financiers to locate a shop (maintenance yard) in Sacramento. Construction of the Jeffrey Shop commenced in mid-June 1910 at the site location.

The annexation of the site area and construction of the railyard made the area more desirable for residential development. Various subdivisions were built in the site area over the period of approximately 1915 to 1950. Since the 1910s, the site area has supported a mixture of industrial, commercial, and residential land uses.

2.2.2 Agricultural Land Use

The 1885 Official Ownership Map of Sacramento County indicates that land in the area was owned principally by four pioneer families (Figure 4):

- C.W. Brockway (area roughly between 6th and 7th Avenues);
- William Curtis (area occupied by the site);
- Thomas and Sarah Edwards (roughly the area east of Freeport Boulevard, between 8th and 12th Avenues); and
- Moses Sprague (roughly the area between Bidwell Way and 6th Avenue on both sides of Freeport Boulevard).

The four pioneer families continued to maintain their land holdings until the period between 1907 and 1920 when construction of the railyard was accompanied by residential development and annexation to the City of Sacramento.

Available manuscript agricultural records for the period 1860 through 1880 indicate the pioneer ranches were slowly transformed to diversified farms during this 30 year period:

- 1860: Livestock (horses, hogs, sheep, chicken, cattle), crops (wheat peas, beans, barley, hay, potato), and dairy farming (milk cows, butter);

- 1870 and 1880: Increased livestock and dairy farming activity, addition of hop vines, apple and other unidentified orchards, and wine and table grapes.

The manuscript agricultural records for 1890 were destroyed in a fire and no more manuscript agricultural records were produced. However, it appears that farming practices continued in the site area until industrial, commercial, and residential development increased during the period from 1910 through 1920.

2.3 RESIDENTIAL LAND DEVELOPMENT - THE SITE AND AREA TO THE WEST

Residential neighborhoods immediately to the west of the railroad yard were subdivided during the period from 1908 to 1920. The majority of residential buildings in the area west of the site were constructed during the period between 1920 and 1950.

3.0 SUMMARY OF PREVIOUS REMEDIAL INVESTIGATIONS AND RESULTS

Provided in the following text is a summary of the Phase 1 and 2 RIs, additional groundwater investigations and results, and the Baseline Health Risk Assessment, as presented in the RI/FS Report.

3.1 PREVIOUS REMEDIAL INVESTIGATIONS

Previously, air, soil and groundwater were evaluated during two phases of remedial investigations:

- Phase 1 RI during 1988; and
- Phase 2 RI during 1989.

Additional groundwater investigations were conducted during winter of 1989 and spring of 1990. All of the investigations have concentrated on the inactive portion of the site, where most of the former railroad yard maintenance activities were completed.

Site conditions were previously characterized by evaluating the data generated from 53 exploratory borings, 31 of which were completed as groundwater monitoring wells, over 250 test pits and numerous additional exploratory excavations during two phases of remedial investigations during 1988 and 1989. Soil samples for laboratory analysis were collected from the pits and borings, and water samples were obtained from two different saturated zones underlying the site. The maximum depth investigated was 150 feet below ground surface (bgs), but most investigations were concentrated near the surface.

During the course of the investigations, over 600 soil samples were collected and analyzed for metals, and approximately 700 soil samples were collected and analyzed for organics. Soil sampling procedures and protocol, field QA/QC measures, and analytical testing methods were in accordance with criteria established in the DTSC-approved Work Plan (Dames & Moore, 1989).

Groundwater samples were obtained from both the top and base of the uppermost (shallow) aquifer zone encountered on- and off-site and from a lower, deeper aquifer zone encountered on-site. Groundwater samples were selectively analyzed for metals, aromatic and chlorinated volatile organic compounds (VOCs), total petroleum hydrocarbons (TPH), polyaromatic hydrocarbons (PAHs), and pesticides and polychlorinated biphenyls (PCBs).

Air monitoring was carried out to analyze ambient air for the potential presence of asbestos, arsenic, copper, lead, and total particulates.

3.2 RESULTS OF PREVIOUS REMEDIAL INVESTIGATIONS

The surface and subsurface soils consist of a heterogeneous mixture of clays, silts and sands laid down by shifting rivers.

Two major categories of contaminants were detected within soils and groundwater at the site. They are metals and organic compounds. Additionally, asbestos was detected in soils.

Results of the air monitoring indicated that air quality was not impacted by contaminants at the site, and that air quality at the site is typical of urban air.

Provided in the following sections is a summary of previous remedial investigation results for soil and groundwater.

3.2.1 Geology and Hydrogeology

The site is located within the Sacramento Valley and is underlain by sediments which are characteristic of flood plain deposits laid down by continually shifting streams. The soils, therefore, consist of a heterogeneous mixture of clays, silts and sands.

At the southern end of the inactive portion of the site, in which most investigation was carried out, the soil profile can be summarized as:

Typical Depth (ft)	Material
0-2	Fill; mainly derived from native soils at the site in site levelling, also contains man-made materials in places.
2-25	Silty clay and clayey silt; contains a hardpan layer of low permeability near the surface over much of the site.
25-35	Sands, silts, and clays; interbedded fine grained materials, fining upwards. The water table can extend upward into this material.
35-50	Sand, fine- to medium-grained; maximum thickness 25 feet, thinning to 4 feet in the southwestern corner of the site and absent in the southeastern and northeastern corner of the site. The base of the sand is the base of the shallow aquifer zone.
50-60	Clay and silty clay aquitard zone; varies in thickness from 10 feet to 40 feet, becomes siltier with depth.

60-150 Interbedded sands, silts and clays, including the lower aquifer zone.

The fill is thicker in the northern half of the inactive portion of the site, and was found to be as thick as 8 to 12 feet in places. The other units listed above appear to be generally continuous over most of the site, although their thickness and texture change. There are two other soil zones which appear restricted to the northern portion of the site. They are an interbedded fine grained zone and a medium sand zone which directly underlie the fill.

Water is encountered at a depth of approximately 30 feet beneath the site surface. The uppermost, shallow aquifer zone is composed mainly of the fine- to medium-grained sand zone, although the aquifer appears unconfined and extends up into the finer overlying material. The horizontal hydraulic gradient for the shallow aquifer zone in the inactive portion of the site ranges from approximately 0.002 in the northern portion to 0.003 in the southern portion. Groundwater flow direction varies across the site from primarily due south in the northern portion to southeast in the southern portion. Most of the site groundwater investigations were conducted within this shallow, uppermost aquifer zone.

The shallow aquifer zone appears continuous over most of the inactive portion of the site, thinning to approximately four feet in the southwestern portion of the site, but pinches out in the extreme southeastern and northeastern portions of the site. Off-site to the southeast, the shallow aquifer zone appears to thin and pinch out. The underlying aquitard appears continuous across the inactive portion of the site but varies in thickness from approximately ten feet to 40 feet.

There is a lower, deeper aquifer zone underlying the aquitard which consists of interbedded sands, silts, and clays. Based on the information available, the zone does not appear to contain any continuous thick sand aquifers.

There are a total of seven irrigation and dewatering wells within a one-mile radius of the site. The wells are typically screened at intervals from just less than 100 feet to 300 feet below ground level. The wells are, therefore, deeper than both the shallow and deep aquifer zones investigated on-site. The wells are not used to supply public drinking water, but are used for irrigation purposes only. The nearest public drinking water supply well downgradient of the site is approximately two miles south of the site.

3.2.2 Soil Contamination

Results of the previous investigations indicated that soils in areas of the inactive portion of the site contained metals, primarily arsenic and lead, organic compounds, primarily diesel range hydrocarbons, and asbestos. Very little data are available on the active portion of the site as the investigations have concentrated on the inactive portion of the site where the majority of the former maintenance yard activities were conducted.

3.2.2.1 Metals in Soil

On the basis of the Phase 1 and 2 investigations, soil arsenic and lead concentration contours were developed and provided in the RI/FS Report. Based on the concentration contours, approximately 24 acres of the inactive portion of the site appeared to have been impacted by arsenic and approximately 32 acres by lead. The distribution of arsenic and lead in soils was interpreted as related to former site railroad activities, the higher concentrations in the upper surface soils (0.0 to 0.5 feet below ground surface), associated with the formerly more active portions of the site (now the inactive portion of the site).

Natural background levels for arsenic and lead were assessed at 8 and 22 mg/kg respectively. Levels of metals in residential lots to the east, although slightly elevated in relation to the assessed background levels, were not considered problematic, and no correlation to the site was indicated.

3.2.2.2 Organic Compounds in Soil

Organic compounds detected in soils in the inactive portion of the site consist of diesel and gasoline petroleum hydrocarbons, aromatic and VOCs, PAHs, and PCBs. Aromatic compounds were generally found associated with gasoline range petroleum hydrocarbons, and PAHs were generally found associated with diesel range petroleum hydrocarbons in the areas discussed below.

Petroleum hydrocarbons, primarily diesel range, were identified in ten general areas of inactive portion of the site (Figure 5) during the two previous phases of investigation as presented in the Report. These ten general areas, most of which can be related to historical sources, are:

- Area A: Fueling Station Area;
- Area B: 1,000-Gallon Underground Storage Tank Area;
- Area C: 18,000-Gallon Underground Storage Tank Area;
- Area D: 72,000-Gallon Underground Storage Tank Area;
- Area E: Above-Ground Storage Tank Area;
- Area F: Oil House Area;
- Area G: Storm Drain Trench Fill Area
- Area H: Central Fill Area;
- Area I: Additional Fill Area; and
- Area J: Additional Fill Area.

Petroleum hydrocarbons were generally not detected at the surface but found a minimum of one foot below ground surface. In the southern, formerly more active area of the now inactive portion of the site, petroleum hydrocarbons appear primarily to be distributed in shallow soils (1 to 5 feet below ground surface), in the area of former tank locations and the former Fueling Station Area. In the central portion of the inactive portion of the site (Area H: Central Fill Area), petroleum hydrocarbons are primarily associated with fill materials. In the former Oil House Area (Area F), gasoline range hydrocarbons were detected in groundwater.

PCBs were detected in a very limited area of the inactive portion of the site (a former transformer vault area). The levels detected were below the levels of concern identified in the risk assessment.

3.2.2.3 Asbestos

Asbestos was detected at low levels primarily in the area of the former Asbestos Storage Building, in the southwest corner of the inactive portion of the site. Asbestos at the site was not considered to be present in significant amounts.

3.2.3 Groundwater Contamination

Results of the previous investigations indicated that groundwater may have been impacted by several metals, and is impacted by organic compounds, primarily aromatic and chlorinated VOCs.

3.2.3.1 Metals in Groundwater

Metals were detected in groundwater samples at concentrations which in general reflect natural background levels in groundwater. Cobalt, copper, chromium, silver, and nickel were detected in groundwater samples at concentrations possibly in excess of background levels but below drinking water standards. The groundwater is not used for public supply, and the levels of metals do not impose a risk to human health.

3.2.3.2 Organics in Groundwater

Organic compounds were detected in several groundwater monitoring wells.

Purgeable aromatic compounds, primarily benzene, and several chlorinated volatile compounds were detected in the southeastern portion of the site. All of the detections were in the uppermost, shallow aquifer zone except for low concentration detections of benzene, 1,1-DCA, 1,1-DCE, and TCE in the lower, deep aquifer zone.

On the basis of comparison with drinking water standards, the constituents of concern in the groundwater are benzene and the chlorinated VOCs 1,2-DCA, 1,1-DCE, 1,1-DCA, and TCE. Only in the case of benzene, 1,2-DCA, 1,1-DCE, and TCE concentrations were the regulatory drinking water standards exceeded.

Benzene appears to be primarily restricted to the former Oil House Area and has only been detected in sampling locations immediately adjacent to this area off-site. The migration of the purgeable aromatic plume appears to have been somewhat impeded by the finer grained materials in the top of the upper aquifer zone.

Chlorinated VOCs have been detected in groundwater samples off-site extending to the furthest downgradient location sampled to date. Further off-site groundwater investigations are ongoing. The migration of the chlorinated VOC plume appears to be directly related to the coarser grained channel sand sediments at the base of the shallow aquifer zone. Detections of these compounds are consistent in sampling locations located along the channel axis which runs generally in a northwest-southeast direction. Two smaller areas of chlorinated VOCs at lower concentrations have been located on-site.

3.3 BASELINE HEALTH RISK ASSESSMENT

A Baseline Health Risk Assessment (HRA) was conducted to evaluate potential health risks associated with chemicals detected in the soil in the inactive portion of the site. The Draft HRA was submitted to DTSC as Appendix F of the RI/FS Report. The results of the Draft HRA indicate that exposures to lead, arsenic and beryllium potentially provide elevated health risks compared with the risks associated with background concentrations of these metals in soil (i.e. concentrations in soil not associated with former activities at the site). Site-specific calculated health risks for arsenic must be considered in the context that background average concentrations off-site are associated with a lifetime cancer risk of 10^{-5} when using standard exposure assumptions. The pathways providing the largest contribution to health risks were inhalation of resuspended dust and soil ingestion. Crop ingestion from fruits and vegetables grown in backyard gardens in off-site soils receiving particle deposition, presented lower health risks when compared to soil ingestion, fruits and vegetables grown in on-site soil or inhalation of chemicals in resuspended dust. Metals and VOCs have been detected in groundwater on- and off-site; however the exposure pathway from chemicals detected in ground water to human populations was considered incomplete. Aquifers near the site that have been impacted by contaminants are not used for drinking water and existing drinking water supplies are distant from the site.

4.0 SUPPLEMENTARY REMEDIAL INVESTIGATIONS

The DTSC finalized the RI/FS Report in May 1991 without the incorporation of additional supplementary data generated since the draft RI/FS Report was submitted in August 1990. Several supplementary soil and groundwater investigations have been completed since submittal of the draft RI/FS Report. These supplementary investigations are listed chronologically below.

- Asbestos trenching activities, August-November 1990;
- Supplementary groundwater investigations, September-October 1990;
- Additional on-site groundwater investigations, February, 1991;
- Additional off-site groundwater monitoring well installations, May 1991;
- Additional on-site soil and groundwater investigations, May-June 1991;
- Additional off-site soil investigations, May-July 1991; and
- Revised Baseline Health Risk Assessment, November 1991.

Described in the following sections are summaries of the supplementary investigations.

4.1 ASBESTOS INVESTIGATIONS

Results of the previous remedial investigations indicated that the surficial soils in the area of the former Asbestos Storage Building in the southwest corner of the inactive portion of the site contained minor amounts of asbestos. Focused shallow sampling activities were conducted in August 1990, in the immediate vicinity of the former asbestos storage building to refine the volume estimates for the subsequently planned interim remedial measure (IRM) of removing the asbestos-contaminated soil. Results of the focused surface soil sampling indicated approximately 60 cubic yards of material would need to be removed (Figure 6).

On the basis of the focused soil sampling, a Work Plan (Dames & Moore, 1990c) for the removal of the asbestos-contaminated soil was developed, submitted to and approved by DTSC, and implemented, commencing October 22, 1990. As excavation continued, it became clear that a significantly larger volume of asbestos contaminated soil was present in the area than previously assessed. At the direction of UPRR, the excavation activities were shut down and stockpiled soils and excavation areas covered by plastic sheeting and covered by weights to safeguard against potential ancillary airborne contamination.

Trenching activities were subsequently conducted in the former Asbestos Storage Building area, in the southwest corner of the site, to further evaluate the extent of asbestos-containing soils. The trenching activities were conducted in November, 1990. Over 1200 linear feet of exploratory trenching was completed in the former Asbestos Storage Building area. Subsurface soils were visually examined for the presence of suspect asbestos-containing materials. Soil samples were collected and analyzed for asbestos.

Results of the asbestos trenching and sampling activities were provided to the DTSC in a letter dated November 15, 1990. Summary results are presented in Section 5.2.4. Trenching locations are presented in Figure 7, summary analytical laboratory results are provided in Table 1, and analytical laboratory reports are provided in Appendix F.

4.2 SUPPLEMENTARY GROUNDWATER INVESTIGATIONS

Results of the previous remedial investigations indicated shallow groundwater had been impacted by chlorinated VOCs off-site to the southeast of the former maintenance yard, and the full extent of the impacted groundwater was not known. To further assess the off-site extent of chlorinated VOCs in shallow groundwater, a total of 50 Cone Penetrometer Test (CPT) and 48 Hydropunch™ (HP) exploratory holes were completed during September and October 1990 at locations on the UPRR site, City of Sacramento property (city streets), and the Sacramento Children's Home (Figure 8). Initial CPT/HP locations were chosen based on available groundwater hydraulic and chemical data developed during previous investigation activities, as described in the DTSC-approved Supplementary Groundwater Investigation Work Plan (Dames & Moore, 1990b). The number of CPT/HP locations was subsequently expanded to include additional downgradient locations (assuming a southeasterly hydraulic gradient) on the basis of significant detections of selected chemical parameters during field analyses by an on-site mobile laboratory. In addition to the CPT/HP investigation, a round of groundwater monitoring well sampling was completed in September, 1990.

Results of the CPT/HP investigations, analytical laboratory reports and geologic cross sections and boring logs were provided in the Supplementary Groundwater Investigation Report (Dames & Moore, 1991a). The results of the supplementary groundwater investigations are incorporated into the supplementary investigation results provided in Section 5.0.

4.3 ADDITIONAL ON-SITE CPT/HP INVESTIGATIONS

Results of the supplementary groundwater investigations and monitoring indicated a potential source of chlorinated VOCs upgradient (northwest) of groundwater monitoring well MW-33 in the Central Fill Area (Area H on Figure 5) of the site. Additional CPT/HP sampling was conducted on-site in February 1991 to further evaluate the upgradient extent of chlorinated VOCs in shallow groundwater beneath the Central Fill Area. A total of three CPTs (CPTs 74, 75, and 76, Figure 8) were conducted and ten HP samples (HP 76 through 85) collected upgradient of groundwater monitoring well MW-33 in the Central Fill Area of the site. The additional on-site groundwater investigations were conducted in accordance with the DTSC-approved Letter Work Plan (Dames & Moore, 1991b) with the same methodology as the previous CPT/HP investigations.

Results of the additional on-site CPT/HP investigations are incorporated into the supplementary investigation results provided in Section 5.0. CPT logs, and analytical laboratory reports are provided in Appendices B and F, respectively.

4.4 ADDITIONAL OFF-SITE GROUNDWATER MONITORING WELL INSTALLATIONS

Results of the Supplementary Groundwater Investigation conducted in September-October 1990, indicated shallow groundwater impacted by chlorinated VOCs from the former maintenance yard and extending approximately 3,000 feet southeast. Further evaluation of the vertical and lateral extent of impacted groundwater was proposed by placing six groundwater monitoring wells at four off-site downgradient locations on City and private property (Work Plan, Off-Site Groundwater Monitoring Well Installations, Dames & Moore 1991c). DTSC approved the Work Plan, and the three monitoring wells were installed on City property in May 1991, as follows:

- MW-34: installed on the sidewalk on Coleman Way, and screened approximately 25 to 40 feet below ground surface, across the water table;
- MW-35: installed adjacent to MW-34, and screened approximately 55 to 60 feet below ground surface at the base of the shallow sand aquifer; and
- MW-39: installed on the sidewalk on 18th Avenue, and screened approximately 25 to 40 feet below ground surface, across the water table.

The installation of three groundwater monitoring wells on Sacramento Children's Home property was delayed pending resolution of the access and lease agreement between UPRR and the Sacramento Children's Home. The three groundwater monitoring wells are scheduled to be installed on Sacramento Children's Home property in November 1991.

Results of the additional off-site groundwater monitoring well installations are incorporated into the supplementary investigation results provided in Section 5.0. Monitoring well logs, and analytical laboratory reports are provided in Appendices B and F, respectively.

4.5 ADDITIONAL ON-SITE SOIL AND GROUNDWATER INVESTIGATIONS

Based upon comments made by DTSC on the draft RI/FS Report (Dames & Moore, 1990a), and as discussed during a meeting between representatives of DTSC, UPRR and Dames & Moore, an additional on-site soil and groundwater investigation was required to supplement the previous findings as provided in the draft RI/FS Report (Dames & Moore, 1990a) (see DTSC comments, Appendix H). The additional soil and groundwater investigations were conducted during May and June 1991 in accordance with the DTSC-approved Work Plan (Dames & Moore, 1991e).

Results of the additional on-site soil and groundwater investigations are incorporated into the supplementary investigation results provided in Section 5.0. Test pit, soil boring, and groundwater monitoring well logs are provided in Appendix B. Soil and groundwater sampling procedures and protocol are described in Appendix A. Analytical laboratory reports are provided in Appendices E and F.

4.5.1 Additional On-Site Soil Investigations

DTSC specifically requested that soils of the following five areas on-site be further investigated by exploratory trenching, sampling and analysis:

- Northern portion of the site;
- Adjacent to the 72,000-gallon underground storage tank (Area D);
- Location of a previously unidentified aboveground storage tank;
- Location of a former 1,000-gallon underground storage tank (Area B); and
- Location of a former transformer vault (Area K).

Shallow soils were also further investigated in the Storm Drain Trench Fill Area (Area G), the Central Fill Area (Area H) and the former Oil House Area (Area F). Locations of test pits (P-254 through P-271) and two soil borings (SB-23 and SB-24) completed in these areas are shown on Figure 9. Summary analytical results are presented in Tables 1 through 4. Analytical laboratory reports are presented in Appendices E and F.

Also to address DTSC comments on the draft RI/FS Report, a soil gas survey was conducted on-site. The soil gas investigation was conducted in accordance with the DTSC-approved Work Plan (Dames & Moore, 1991e). Two areas at the facility were investigated:

- Vicinity of the former Oil House Area (Area F): The purpose of the soil gas survey was to assess if significant levels of soil gas exist in the former Oil House Area and could potentially migrate to adjacent residential yards; and

- Central Fill Area (Area H): The purpose of the soil gas survey was to further assess the distribution of VOCs in shallow soils.

A total of 36 soil gas samples from 25 different locations were collected from the former Oil House Area and the Central Fill Area of the site during the investigation. Summary analytical results are provided in Table A-4. Soil gas sample locations and concentration contours are presented in Appendix A.

Additionally, a focused investigation was conducted on some of the areas of the site surface covered by slag. Subsequent to Phase 1 and 2 investigations and submittal of the draft RI/FS Report to DTSC, slag was identified as a possible source of metals detected in soils. The slag was used by the railroad primarily as a track ballast, and as such, is distributed primarily in linear areas previously or currently occupied by railroad track.

Approximate grain size and distribution of the slag was mapped and is presented in Figure 10. A total of 57 samples of slag and underlying soil were collected from 19 test pits, P-272 through P-290, excavated within mapped areas of slag shown in Figure 10. Additionally, the mineral form of the slag was identified by energy dispersive electron microprobe analysis (EDA), and elemental x-ray maps and back-scattered electron images (BSE) were completed to document the presence of selected elements.

Summary soil and slag analytical results are presented in Table 5. Sampling procedures, protocol, and investigative results are described in detail in Appendix A, and test pit logs are provided in Appendix B. The results of the EDA and BSE are provided in reports by Dr. E. U. Petersen of the University of Utah (Appendix F).

4.5.2 Additional On-Site Groundwater Investigations

Four groundwater monitoring wells, shown in Figure 8, were installed on-site in May 1991 to further assess the extent of chlorinated VOCs in groundwater, as follows:

- MW-40: installed adjacent to MW-32, and screened approximately 73 to 83 feet bgs in the next lower sand unit beneath MW-32 (the unit screened in MW-12 and MW-28) to further evaluate the vertical extent of chlorinated VOCs in this area;

- MW-41: installed adjacent to MW-12, and screened approximately 115 to 125 feet bgs in a lower sand unit beneath MW-12, to further evaluate the vertical extent of chlorinated VOCs in this area;

- MW-42: installed in the northwestern portion of the Central Fill Area, and screened approximately 25 to 40 feet bgs, across the water table, to further evaluate chlorinated VOCs in this area; and

- MW-43: installed in the southwestern portion of the Central Fill Area, and screened approximately 25 to 40 feet bgs, across the water table, to further evaluate chlorinated VOCs in this area.

The four groundwater monitoring wells were developed and sampled in June 1991.

4.5.3 Investigative Field Methods

All field procedures and protocol were performed in accordance with the DTSC-approved Work Plan (Dames & Moore, 1991c). Details of sampling, excavation, and drilling, procedures and protocols are provided in Appendix A, lithologic logs are provided in Appendix B, comprehensive analytical results are provided in Appendices C and D, and analytical laboratory reports are provided in Appendices E and F.

4.6 OFF-SITE SOIL INVESTIGATIONS

Previous off-site soil investigations conducted in 1989 focused on several residential lots the east side of the site and two vacant lots on the west side of the site. The previous investigations were not presented in detail in the RI/FS Report, and a summary discussion is provided in Section 4.6.1.

Supplementary off-site soil investigations completed during 1991 were concentrated along the west side of the active track area of the site. The off-site investigations consisted mainly of an evaluation of shallow soils for metals contamination. Described in Section 4.6.2 is a summary of the supplementary off-site soil investigations.

Results of the off-site soil investigations are provided in Section 5.2.1.2. Lot locations are presented in Figure 11. Sample locations and summary analytical results are presented in Figure A-3 through A-10, and Tables A-1 through A-3. Analytical laboratory reports are provided in Appendix F.

4.6.1 Previous Off-Site Soil Investigations

Previous investigations, which are discussed in detail in Appendix A, consisted of two separate evaluations:

- During the Phase 2 RI, completion of one test pit in each of two vacant UPRR lots (Lots 1 and 2 on Figure 11) on the west side of the active portion of the site; and
- Subsequent to the Phase 2 RI, sampling of three residential backyards on the east side of the inactive portion of the site (Figure 11).

Soil analytical results for the surface sample from Lot 1 indicated elevated levels of arsenic, copper, and lead with respect to background. Analytical results for other soil samples from Lots 1 and 2 indicated metals at levels generally considered background or acceptable concentrations.

Review of analytical results for soil samples from the east-side residential lots indicated levels of lead were possibly elevated with respect to background. However, no correlation of sample location could be made with proximity to the railroad yard. In light of the information presented in Section 5.2.2.1, other potential anthropogenic sources, such as household lead-based paint, may be the main contributor to elevated lead levels in soils, and not former railroad yard activities.

4.6.2 Supplementary Off-Site Soil Investigations

Supplementary off-site soil investigations were conducted on the west side of the site during January, May, June, and July 1991 under the direction of DTSC.

The January 1991 soil investigation focused on one vacant lot (Lot 1, Figure A-3). Lot 1 was previously owned by UPRR, but was sold to a private individual in July 1990. Lot 1 was sampled at the request of UPRR to further evaluate if elevated levels metals were present in soil, and if so, to develop a clean-up plan for the lot.

Three residential lots, two vacant lots, and one commercial lot were the focus of the supplementary soil investigations during May through July 1991 (Figure 11). The May through July 1991 soil investigations were initially requested by the community and subsequently directed by DTSC to evaluate potential off-site metal contaminant migration on to private property from the adjacent railroad yard. The vacant lots were two of four vacant lots (Lots 1, 2, 3, and 4 on Figure 11) historically owned by UPRR. Based on historical aerial photographs, the lots appear to have been utilized for parking cars. Additionally, one of the residential lots (2206 6th Avenue) also appears to have been used for parking. No railroad maintenance activities are known or believed to have been conducted on the lots.

Provided in Appendix A is a discussion of the chronology of the events leading up to and including the sampling activities, a description of the supplementary off-site soil sampling methodology and investigative results.

4.7 REVISIONS TO THE BASELINE HEALTH RISK ASSESSMENT

The Draft HRA summarized in Section 3.3 was reviewed by the DTSC and comments were provided to UPRR in March 1991. The DTSC comments were not addressed in the RI/FS Report, but are addressed in this Addendum RI/FS. Based on the comments provided by the DTSC, the Draft HRA underwent revision, which included recalculation of the health risks. The principal revisions made to the Draft HRA in response to the agency comments were:

- Inclusion of ground water exposure pathways;
- Revision of air modeling to estimate concentrations of chemicals in air (from the resuspension of dust) at the fenceline of the site;
- Recalculation of concentrations in surface soil used to calculate intake rates from direct contact exposure pathways (i.e. soil ingestion and dermal contact);
- Revision of the exposure scenarios to more specifically account for risks to trespassers, off-site residents and potential future on-site residents;
- Use of 10 ug/dL (rather than 15 ug/dL) as an acceptable blood-lead level.
- Summation of health risks from all exposure pathways.

Three hypothetical exposure scenarios were evaluated in the revised baseline HRA:

- Trespasser - an individual who scales the fence surrounding the site, or otherwise gains access to the currently vacant site;
- Off-site resident - an individual who is located at a residence that is at the fenceline of the site;
- On-site resident - an individual who is located at a residence that is assumed to be built on the site in the future.

As required by EPA and DTSC guidelines, health risks were evaluated for both current and hypothetical future land uses.

The exposure pathways addressed in the Revised HRA are listed below for the three exposure scenarios. The current land use trespasser exposure pathways are:

- Inhalation of resuspended dust;
- Soil ingestion of on-site soil; and
- Dermal contact with on-site soil.

The current land use off-site resident exposure pathways are:

- Inhalation of resuspended dust;
- Soil ingestion of off-site soil; and
- Dermal contact with off-site soil.

In this exposure scenario, chemicals in soil on-site are assumed to become resuspended along with surface dust and deposited onto off-site soil. The future land use off-site resident exposure pathways are:

- All of the pathways listed above for the current land use off-site resident; and
- Ingestion of off-site ground water;
- Dermal contact with off-site ground water during bathing or showering; and
- Inhalation of volatile organic compounds emitted from off-site ground water during showering.

The future land use on-site resident exposure pathways are:

- Soil ingestion of on-site soil;
- Ingestion of on-site ground water
- Dermal contact with on-site soil;
- Dermal contact with on-site ground water during bathing or showering; and
- Inhalation of VOCs emitted from on-site ground water during showering.

5.0 SUPPLEMENTARY REMEDIAL INVESTIGATION RESULTS

Described in the following sections are the results of the investigations completed since submittal of the draft RI/FS Report in August 1990. Data presented in previous documents are summarized, but inasmuch as the purpose of this document is to supplement the RI/FS Report, discussion of previous data is restricted to cases where the interpretation of the site conditions has changed from those opinions presented in the RI/FS Report.

5.1 HYDROGEOLOGY

Detailed discussions of the subsurface stratigraphy were previously provided in the RI/FS Report and the Supplementary Groundwater Investigation Report (Dames & Moore, 1991a). Groundwater monitoring well and CPT/HP locations are presented in Figure 8. A geologic cross section is provided as Figure 12. A shallow groundwater contour map is provided as Figure 13.

The basis for the stratigraphic interpretation is the information from 76 CPTs and 62 boring logs completed generally to a depth of about 60 to 70 feet bgs. The majority of the boring logs are generated from field observation of continuous cores drilled mainly on-site. The majority of the off-site data comes from CPT logs, with only three borings (MW-34, MW-35, and MW-39, Figure 8) completed at two off-site locations to the southeast.

5.1.1 Stratigraphy

As presented in the RI/FS Report, the site and surrounding area is underlain by sediments characteristic of flood plain deposits laid down by continuously shifting streams. The subsurface stratigraphy consists of a heterogeneous mixture of clays, silts, and sands.

The primary pertinent subsurface hydrogeologic feature encountered on-site during this and previous investigations is a generally traceable sand zone (Zone F on Figure 12). Zone F consists of a fine- to medium-grained sand to silty sand which contains pebble and coarse sand lenses towards the base and fines upwards. The base of the sand is an erosional surface generally on clay or silty clay.

The sand zone (Zone F) thins on the south end of the site and is thickest at the location of groundwater monitoring well MW-2 in the northern section of the inactive portion of the site. The sand zone pinches out to the northeast of MW-2, and is not present at the location of MW-1.

Southeast of the site, the sand zone thickens to 25 feet at the location of groundwater monitoring well MW-34. Continuing southeast from MW-34, the sand zone thins and finally pinches out approximately at the location of CPT-35/HP-39, just south of Sutterville Road.

There is little evidence of sand in the CPT logs from the area of investigation southeast of Sutterville Road. The zones of silts or silty sands appear very thin from Sutterville Road to the south. A thick, coarse unit of soil was encountered at the location of groundwater monitoring well MW-39, at the southeast extent of the area of investigation. Silty sands were logged at a depth of 36 to 43 feet bgs based on continuous cores.

There is limited data on deeper stratigraphy, and all of the data are limited to the site. Only five borings have been advanced to a depth of greater than 90 feet bgs, and four of those borings were advanced to at least 115 feet bgs.

Based on the logs of four of the five deeper borings completed as groundwater monitoring wells (MW-12, MW-28, MW-40, and MW-41), beneath the sand (Zone F) lies a clay to silty clay unit (Zone G) which varies in thickness from approximately 10 to 20 feet.

Zone G is underlain by a zone of interbedded clays, silts and sands, referred to as Zone H. Within Zone H are units of sand and clay which appear to be correlatable between the boring locations. The first sand unit is encountered between approximately 67 and 80 feet bgs. Groundwater monitoring wells MW-12, MW-28, and MW-40 are screened across the first sand unit in Zone H, which is a silty sand (SM in MW-12 and MW-28) to clean sand (SP in MW-40).

Beneath the uppermost sand unit of Zone H lies predominantly silty clays to clayey silt. The next significant sand unit extends from approximately 93 feet to 110 feet and is variable between boreholes. Groundwater monitoring well MW-41 is screened across this unit. In cores from wells MW-12 and MW-41, lenses of clay and silty clay were observed interbedded with sand in this unit, whereas in the core for well MW-28, this unit is primarily fine grained sand.

5.1.2 Groundwater Hydrology

Static water level measurements were obtained in February, April and July of 1991 (Table 6). The July 1991 round of water measurements was used to produce the groundwater surface elevation map shown as Figure 13. This map includes water levels from new groundwater monitoring wells MW-34, MW-35, MW-39, MW-42 and MW-43 installed in May 1991. Monitoring wells MW-12, MW-27, MW-28, MW-40 and MW-41 were not utilized as these wells are screened in deeper zones. Most of the wells are located in the southern part of the inactive portion of the site. The groundwater flow direction is primarily to the southeast across the site. These data generally conform to previous groundwater monitoring data for the site.

The horizontal hydraulic gradient for the site, calculated from data presented in Figure 13, is approximately 0.002 to the southeast across the site. Gradient remains fairly constant seasonally.

Water levels for newly installed wells MW-34, MW-35 and MW-39 provide approximate hydraulic information for the downgradient portion of area of investigation. As there is no directional control due to the geographic locations of the wells, it is not possible to determine an estimation of gradient (magnitude and direction). However, based on July water levels, there is an apparent gradient of 0.002. Water levels in proposed wells MW-36, MW-37 and MW-38 should supplement gradient information after their installation.

Since installation of wells MW-1 through MW-8 in 1987, water level measurement data indicate a drop in water levels has occurred (Table 7). Water levels dropped an average of 2.5 feet over the three year period between February 1989 and February 1991.

Hydrology of the upper sand unit of Zone H was evaluated based on water levels obtained from wells MW-12, MW-28, and MW-40. These wells are screened in what is interpreted to be the same sand unit at approximately the same depth. The wells are nearly in a straight line, which limits the ability to resolve the gradient in this zone. The apparent gradient is to the east. These data are preliminary at best, and additional groundwater monitoring data is required.

To assess vertical gradients, water levels from wells completed in the shallow sand zone (Zone F) and adjacent wells completed in the second significant sand zone were compared. In all three rounds a downward vertical gradient of approximately 0.005 was measurable between the two zones.

5.2 NATURE AND EXTENT OF CONTAMINANTS IN SOIL

As would be suggested by the historical railyard activities and as is indicated by the analytical results, metals, organic compounds (mainly diesel range hydrocarbons), and asbestos are the primary contaminants in soil at the site. This interpretation concurs with results of the two previous phases of investigation presented in the RI/FS Report.

In the northern part of the inactive portion of the site, contaminants below the upper one-half foot of soil/gravel cover are generally associated with fill materials. In the southern part of the inactive portion of the site, contaminants below the upper one-half foot of soil/gravel cover are generally associated with fill materials or the former location of USTs or piping.

The metals which measured at elevated levels in site soils compared to the natural background were arsenic, lead, copper, and zinc. Copper and zinc, apparently associated primarily with arsenic and lead in slag, are not considered problematic based on the health risk assessment. Speciation of petroleum hydrocarbon indicates that principally diesel fuel is present in soils at the former tank locations, in areas of fill, and where piping is present. This finding is consistent with the use of diesel fuel at the yard since the 1950s.

Asbestos was primarily detected in the southwest corner of the site in the former Asbestos Storage Building Area.

Provided in the following sections are results of the supplementary soil and groundwater investigations.

5.2.1 Areas of Fill Containing Debris

As discussed in the RI/FS Report, apparent historical cut-and-fill practices at the site resulted in multiple generations of locally derived fill containing natural and man-made materials. The distribution of fill is presented in Figure 14. The fill consists of silty clay, silty sands, and/or gravels, and contains demolition debris and other materials including wood, concrete rubble, dry wall fragments (gypsum board), iron, coal and coal cinders, metal debris, and slag. Several drums, some empty and some containing petroleum-based fluids, have been recovered from the fill materials during the field investigations.

During the recent on-site soil investigations (Section 4.5.1), the extent of debris containing fill was further investigated in several areas of the inactive portion of the site:

- The northern part of the inactive portion of the site;
- The Central Fill Area (Area H on Figure 5); and
- The Storm Drain Trench Fill Area (Area G on Figure 5).

The results of these investigations are detailed in Appendix A. The extent of fill containing debris is presented in Figure 15.

5.2.2 Metals

Metals, primarily arsenic and lead, have been detected in site soils and the distribution appears related to past site activities. Provided in the following sections are interpretations of the results in addition to summary comments relating to any changes in interpretations previously presented in the RI/FS Report.

Results of the recent investigations are provided in Appendix A. Analytical results are summarized in Table 2, comprehensive analytical results are provided in Appendix C, and analytical laboratory reports are provided in Appendix F. Test pit locations are provided in Figure 9, and test pit logs are provided in Appendix B.

5.2.2.1 <u>Background Metals Concentrations and DTSC Level of Concern</u>

Background samples were collected during the Phase 1 and 2 RIs from nearby Curtis Park and William Land Park to assess naturally occurring levels of arsenic, lead, and copper in soils. The results as presented in the RI/FS Report indicated background levels of arsenic at 8 ppm, lead at 22 ppm, and copper at 23 ppm. The previous background sampling did not take into account the information presented below.

Results of the additional historical evaluation indicates the area of the site was utilized for agricultural purposes. Historical agricultural practices included the use of pesticides, herbicides, and insecticides containing arsenic, lead, and copper, suggesting that these metals may be elevated in soils in the area of the site due to past agricultural practices. The distribution of metals in soil from historical agricultural applications is not possible to assess, due to the unavailability of records or documentation of such practices.

Prior to the 1950s, lead concentration in paint was as high as 50 percent. In the mid-1950s, paint manufacturers voluntarily limited the amount of lead in paint to one percent. In 1977, the amount of lead in paint was limited to 0.06 percent by the Consumer Safety Act. Results of studies conducted by the Department of Health Services (DHS, 1991) indicate that lead levels in older residential areas may be elevated due to the contribution of lead-based paint from the older houses. These DHS studies were conducted primarily to evaluate childhood lead poisoning. While the DHS studies are inconclusive, they suggest that the average household soil lead level in older portions of Sacramento (predating the reduction in lead in paint) is 230 ppm, with a range of 26 ppm to 2,700 ppm. The houses in the Curtis Park residential area, which borders the site on three sides, were built mainly during the period 1920 through 1940, predating the reduction in lead in household paint. This suggests that the Curtis Park area soil lead levels may be significantly elevated above the assumed natural background lead level of 22 ppm.

The DTSC evaluated results of the metals measured in shallow soils of residential lots (Section 5.2.2.3). The evaluation was reported in the DTSC Fact Sheet (DTSC, July 1991).

The results of the DTSC evaluation indicated average lead levels present in shallow soils in residential yards at or below 300 ppm to be below a level of concern for potential health risks. Arsenic average soil levels in residential yards between 10 ppm and 30 ppm were not considered by DTSC to impose a significant health risk, although some limited action at resident's discretion was mentioned, for example sodding to minimize potential exposure. Limited actions as discussed above were recommended by DTSC for arsenic average shallow soil levels between 31 ppm and 75 ppm in residential yards. The DTSC considers an average arsenic soil level in a residential yard above 75 ppm cause for concern.

Additional data on arsenic and lead are provided in the Revised HRA (Appendix J).

5.2.2.2 Metals in On-Site Soils

The spatial distribution of arsenic, lead, and slag in soils are provided in arsenic and lead concentration contour maps using the comprehensive soil analytical results generated during previous remedial investigations in addition to the recent Additional On-Site Soil and Groundwater Investigations. These maps are provided as Figures 16 through 23.

The concentration contour maps do not represent precise chemical concentration contours in soils, but delineate measured concentrations at specific sample location points, and approximate the general distribution of concentrations between sample points. Contours were hand drawn using analytical results with sample location, depth, and test pit and soil boring logs. Data was divided into four separate depth intervals:

- 0.0 to 0.5 feet;
- > 0.5 to 1.5 feet;
- > 1.5 to 5.0 feet; and
- > 5.0 to 10.0 feet.

The 0.0 to 0.5 foot interval contains data from composite surface samples (Phase 2) and slag samples in addition to data from samples within the 0.0 to 0.5 foot interval. Where more than one sample was collected at the same sample location within the same depth interval, the high value was utilized to obtain a conservative estimate of volume and distribution.

The concentration contour figures show generally elevated levels of arsenic and lead, fairly widespread across the site, and the distribution seems primarily to be associated with the former track locations and former active portions of the site. Additionally, the contours indicate the approximate areal extent of metal-impacted soil decreases rapidly with depth, and approximately 2.0 feet bgs appears to primarily be associated with fill soils.

The distribution of metals across the site suggests more than one source. At least one of the sources of arsenic, lead copper, and zinc is the slag which was used for railroad track ballast. The slag is generally present in areas currently or previously occupied by railroad track.

Results of the slag analyses (Appendix A) indicate the slag is composed of the minerals clinopyroxene, olivine, magnetite, various sulfides, and glass. Arsenic, lead, copper, and zinc are present primarily in sulfides — generally considered the most stable insoluble form of the metals. The source of the slag is indicated as a byproduct of copper-ore smelting from the Kennecott Garfield Smelter in Utah.

Additional sources of arsenic in site soils is indicated by compounds which were potentially used at the site, both prior to the construction of the railroad yard from agricultural practices, and as part of the railroad operation. Lead arsenate and calcium arsenate have been used as insecticides in agriculture since the latter part of the 17th century. Paris Green, a cuprous arsenite, was used to control the Colorado Potato Beetle in the eastern United States in 1867. Sodium arsenite was widely used for weed control, as a fungicide on grapes, and as a defoliant to kill potato vines prior to harvest. Arsenic is known to be a constituent in certain wood preservatives, and as a pigment in paint.

Additional potential sources of lead found in site soils may be an artifact of lead-containing materials commonly associated with railroad equipment, emissions from vehicular traffic, and railroad yard activities. Lead/antimony alloy is characteristic of babbitt, a material commonly used in the construction of bearings and sacrificial gears for older locomotives. Lead oxide is a constituent in paint, and is highest in concentration in white paint. Other potential sources of lead include locomotive batteries, dry lubricants, leaded fuels, and certain pesticides and herbicides.

5.2.2.3 Metals Off-Site

Off-site soils were investigated as described in Section 4.6. Soil sample locations and summary analytical results for the supplementary off-site soil investigations are presented in Appendix A. Also provided in Appendix A for discussion purposes is the results of the previous Lot 2 sampling. Summary analytical results are also provided in Tables A-1 through A-3, and in Figure A-3 through A-10. Copies of the analytical laboratory reports are provided in Appendix F.

Soil sample analytical results indicate that shallow soils in Lots 1 and 3 contain levels of several metals which are elevated relative to the natural background concentration for the area, but below the DTSC level considered cause for concern for average metals concentrations in residential yards:

- Lot 1: arsenic, copper, and lead; and

- Lot 3: arsenic and lead.

The levels of metals detected in soils at Lot 2 and Lot 4 are considered typical relative to background and below DTSC levels of concern.

Soil sample analytical results for three residential lots (2212 7th Avenue, 2207 7th Avenue, and 2206 6th Avenue) sampled indicted two of the lots contain levels of metals which may be elevated relative to the natural background concentration for the area:

- 2207 7th Avenue: arsenic and lead; and

- 2206 6th Avenue: arsenic and lead.

The levels of metals detected in soils at 2212 7th Avenue are considered typical relative to background.

Soil sample analytical results show that shallow soils in the commercial lot sampled (2171 Perkins Way) contain elevated levels of arsenic, barium, lead, zinc, methylene chloride, and several aliphatic hydrocarbons.

The distribution of metals in shallow soils off-site suggests multiple potential sources.

Present in shallow soils in Lot 1 and in the residential lot at 2206 6th Avenue is a slag containing gravel which appears to correlate with the areas of soil with elevated levels of arsenic and lead, and when analyzed, copper. As described in Appendix A.2.2, the slag is a byproduct of copper ore smelting and contains arsenic, copper, lead, and zinc in a vitreous matrix of low or negligible solubility. The slag is at least one potential source of arsenic, copper and lead in soils where present, although there may be additional sources of metals in these two lots as well.

Elevated levels of metals were also detected in the residential lot (2212 7th Avenue) adjacent to Lot 1. The levels detected were below the DTSC level of concern. Insufficient sampling was conducted to assess the distribution of metals in the lot. Slag was not observed in soil samples from the residential lot. Potential sources of the elevated levels of lead in the residential lot soils include lead-based paint and herbicides, as well as automobile exhaust emissions from the adjacent driveway. Potential sources of arsenic in the residential lot soil include herbicide applications and pigment in paints.

The distribution of elevated levels of metals in Lot 3 and the adjacent commercial lot at 2171 Perkins Way is suspected to result from past handling practices of hazardous materials at the commercial lot. The commercial lot was historically a paint contractor's warehouse, and subsequently a sign painting company. Paints are a known source of solvents and metals. DTSC is investigating the commercial lot further. Interim remedial measures (IRMs) are planned for Lots 1 and 3, as discussed in Section 5.2.2.4.

5.2.2.4 Interim Remedial Measures Planned for Lots 1, 2, and 3

At the direction of DTSC, interim remedial measures (IRMs) are being conducted on Lots 1, 2, and 3 (Figure 11) as follows:

- Lot 1: Elevated levels of metals, arsenic and lead are contained in the surficial soil (Figure A-3). A minimum of the upper one-foot of soil and gravel, approximately 500 cubic yards, will be removed from the lot. The soil will be visually examined for the presence of any remaining gravel, and any remaining gravelly soil will be removed. Also to be removed are the bushes on Lot 1. The trees will remain undisturbed. Confirmation sampling will subsequently be conducted, and assuming the remaining soils do not contain elevated levels of metals, soil from an off-site source will then be imported to bring the lot up to existing grade;

- Lot 2: Elevated levels of metals were not measured in Lot 2 (Figure A-4). However, the community has complained of dust emissions and traffic. In response to the community complaints, UPRR has agreed to cover the surface of the lot with gravel to minimize dust emissions, and fence the perimeter of the lot to control traffic; and

- Lot 3: Elevated levels of metals were measured in surficial soils along the western side of Lot 3 (Figure A-5). With the exception of the west side of the lot, a chip seal cover exists on Lot 3. The soils on the west side of the lot appear to have originated from surface flow from the adjacent lot, as evidenced by an elevated apron of soil present along the west side of the lot and the fence which has been pushed up from the bottom. Levels of metals in the adjacent lot to the west are also elevated. DTSC is further investigating the lot to the west. The elevated surface soil along the western side of Lot 3 (approximately 20 cubic yards) will be removed and a fresh chip seal cover placed over the entire lot.

The IRMs are being conducted as provided in the DTSC-approved Work Plan (Dames & Moore, 1991g).

5.2.3 Organics

Additional recent investigations were conducted in several potential hydrocarbon source areas previously identified in the RI/FS Report. In addition, some focused investigations were completed in areas not previously investigated for hydrocarbon contamination. TPH concentration contour maps using comprehensive soil analytical results generated during previous investigations, in addition to recent on-site soil and groundwater investigations, provide the spatial distribution of TPH is soils. These maps are provided in Figures 24 through 28.

The concentration contour maps do not represent precise chemical concentrations in soils, but delineate measured concentrations at specific sample location points and approximate the general distribution of concentrations between sampling points. Contours were hand drawn using analytical results with sample locations, depth, and test pit and soil boring logs. Data was divided into five separate depth intervals:

- 0.0 to 1.5 feet;
- > 1.5 to 5.0 feet;
- > 5.0 to 10.0 feet;
- > 10.0 to 15.0 feet; and
- > 15 feet.

Provided in the following sections are the results of the recent investigations in addition to summary comments relating to any changes in earlier interpretations as previously presented in the RI/FS Report. Refer to Figure 5 for hydrocarbon areas.

5.2.3.1 Northern Part of the Inactive Portion of the Site

Previous investigations in this area of the site indicated only very limited hydrocarbon contamination in the northwest corner of the inactive portion of the site. Six additional test pits (TP-254A, TP-254B, TP-255, TP-256, TP-258, and TP-259, Figure 9) were completed in the northern inactive portions of the site, and soil samples were collected and analyzed for organic compounds.

Results of the field investigations and analyses indicate no significant concentrations of diesel range hydrocarbons, pesticides, or PCBs in test pits TP-254A, TP-254B, TP-255, TP-256, and TP-258.

Stained soil was observed in test pit TP-259, between eight and eleven feet bgs beneath buried debris including two drums. The drums were removed and samples collected of the stained soils and unstained native soils below. Diesel range hydrocarbons were measured at 440 mg/kg at a depth of 9.5 feet bgs in the stained soils, and non-detect in the native soils beneath the stained soils. Chlorinated VOCs were not detected in soil samples collected beneath the buried drums.

5.2.3.2 Area B: 1,000-Gallon Underground Storage Tank Area

Area B (Figure 5), the former location of the 1,000-gallon UST, is located in the southern portion of the site, adjacent to the former Main Shop Building. The tank was removed during the Phase 2 RI in September 1989. The previous sampling of Area B as presented in the RI/FS Report consisted of several test pits and soil borings in the general area, and two soil samples collected at the tank excavation pit bottom. Hydrocarbons were detected in samples collected from the tank excavation bottom at concentrations ranging from 210 mg/kg to 7,200 mg/kg.

One additional test pit (TP-261) and one additional soil boring (SB-23) were completed at the location of the former 1,000-gallon UST.

Stained soil was observed to total depth in the test pit (16 feet bgs) and soil boring (32 feet bgs). Samples collected at 3.25 feet bgs (from the pre-existing trench wall) and 16.0 feet bgs were analyzed for diesel range hydrocarbons and chlorinated VOCs. Levels of diesel range hydrocarbons at 3.25 and 16.0 feet were 290.0 and 130.0 mg/kg, respectively, and were non-detect for chlorinated VOCs.

Soil samples were collected at 19.0, 24.0 and 29.0 feet bgs during the advancement of SB-23 and subsequently analyzed for chlorinated VOCs and diesel range hydrocarbons. All three samples were non-detect for both diesel range hydrocarbons and chlorinated VOCs. Additionally, the sample from 19.0 feet was analyzed for purgeable aromatics, and was also non-detect.

The results of the soil investigations in Area B indicate petroleum hydrocarbons at concentrations between 210 and 2,600 mg/kg in the tank excavation pit bottom. Concentrations of hydrocarbons attenuate with depth to 130 mg/kg at 16 feet bgs, and were non-detect at 19 feet bgs. Chlorinated VOCs were not detected in soil samples from Area B.

5.2.3.3 Area D: 72,000-Gallon Underground Storage Tank Area

Area D, the empty 72,000-gallon UST area, is located along the western side of the southern inactive portion of the site (Figure 5). The tank was used historically to store bunker C fuel. The walls and floor of the tank were scraped and steam cleaned during the Phase 2 RI. Currently, the tank is empty of all wastes; all that remains is rainwater which collects seasonally in the tank.

As presented in the RI/FS Report, petroleum hydrocarbons were detected in soil samples at concentrations ranging from 110 mg/kg to 48,000 mg/kg in Area D. The petroleum hydrocarbons appeared to be limited to shallow soils adjacent to the tank. Hydrocarbons were not detected in the samples collected from beneath the tank.

Test pit TP-265 was excavated adjacent to the 72,000-gallon UST, on the north side. No stained soil was observed in TP-265. Additionally, PID readings on soil in test pit TP-265 were at or below background. As a result, no samples were collected from TP-265 for analysis.

Test pit TP-286, a slag investigation test pit, was excavated approximately 40 feet southwest of the southwest corner of the 72,000-gallon tank. A corrugated pipe was encountered in the test pit, and beneath the pipe, hydrocarbons were evident in soil. Soil samples were collected immediately beneath the pipe at 2.75 feet bgs and at 5.0 feet bgs. Diesel range hydrocarbons were measured at 800 and 200 mg/kg, respectively, in the 2.75 and 5.0 foot samples.

Results of investigations in the 72,000-gallon UST area indicate that hydrocarbons appear limited to shallow soils adjacent to the tank, primarily on the west and south sides. Additionally, hydrocarbons may be associated with piping in the area of the tank.

5.2.3.4 Area F: Former Oil House Area

Area F, the former Oil House Area, is located along the eastern side of the southern inactive portion of the site (Figure 5). Area F is the former location of the Oil House Building, which was used historically to store drummed fluids, and the site of a number of above-ground and USTs. The tanks and building were removed in or before 1986.

Petroleum hydrocarbons were previously detected at concentrations ranging from 367 to 11,300 mg/kg in soil samples collected from Area F. The deepest concentrations of petroleum hydrocarbons were 3,090, 166, and 356 mg/kg, respectively, in the 10, 15, and 20 foot samples from soil boring SB-12. Petroleum hydrocarbon concentrations decreased with depth.

Nine soil gas samples were collected from six locations in the vicinity of the former Oil House Area of the site (Appendix A). Analytical results are summarized below.

- Benzene was not detected in any of the soil gas samples in the former Oil House Area;
- Vinyl chloride was not detected in either of the two soil gas samples (SG-1-5 and SG-3-3) analyzed;
- Total volatile hydrocarbons (TVH) were detected in four samples at concentrations ranging from 4 ug/L to 496 ug/L;
- Carbon Tetrachloride (CCL_4) was detected at low levels in three samples, however, it was also detected in ambient air; and
- 1,1,1-Trichloroethane (1,1,1-TCA) was detected in one sample analyzed.

Results of the soil gas survey indicate that while soil gas in the former Oil House Area contains elevated levels of several VOCs, the concentrations are below the level of concern established in the Work Plan (Dames & Moore, 1991e). It is therefore, unlikely that significant concentrations of VOCs are present in the adjacent residential yards.

One additional test pit (TP-266) was completed in the former Oil House Area of the site. The test pit was completed to a depth of 12.5 feet bgs. One sample collected at 6.5 feet below ground was analyzed for diesel range hydrocarbons and aromatic compounds. Results of the analyses indicated 94 mg/kg diesel range hydrocarbons, and non-detect for aromatic compounds.

Results of the additional investigations in Area F indicate low levels of diesel range hydrocarbons in soil, and hydrocarbon levels attenuating with depth. It appears that very low or negligible levels of aromatic compounds are present in soils in Area F, as indicated by soil sample analytical results. The lack of aromatic compounds in shallow soils in Area F is further demonstrated by the soil gas results, which were non-detect for aromatic compounds.

5.2.3.5 Area G: Storm Drain Trench Fill Area

Area G, the Storm Drain Trench Fill Area, is located just inside the western boundary of the inactive portion of the site (Figure 5). Area G overlies a northwest-southeast trending corrugated pipe which interconnects several sumps. Stained soil and mixed soil and debris occupy the area adjacent to the pipe and sumps in Area G. Analysis of soil samples during previous investigations indicated hydrocarbons ranging from 452 mg/kg to 2,450 mg/kg.

One additional test pit (TP-260) was completed in Area G to a depth of eight feet bgs. Test pit TP-260 was completed adjacent to test pit TP-209 for the purpose of providing data on the vertical extent of hydrocarbons in soil.

Stained soil was observed between approximately 5 and 7.5 feet bgs in test pit TP-260, and appeared to be associated with a 12-inch diameter corrugated steel pipe. Two samples were collected and analyzed for diesel range hydrocarbons, one at 5.5 feet and the other at 7.5 feet bgs. Diesel range hydrocarbons were detected at 33.0 mg/kg at 5.5 feet, and were non-detect at 7.5 feet bgs.

Results of the additional sampling in Area G indicate diesel range petroleum hydrocarbons present at 5.5 feet bgs and non-detect at 7.5 feet bgs. The petroleum hydrocarbons appear to be associated with the piping.

5.2.3.6 Area H: Central Fill Area

Area H, the Central Fill Area, is located near the center of the inactive portion of the site (Figure 5). Previous investigations of Area H as presented in the RI/FS Report indicated hydrocarbons in soils ranging from several hundred to 76,000 mg/kg at depths from 2 to 10 feet bgs. Hydrocarbon contamination appeared to be limited to fill soils, within approximately 10 feet of ground surface. Low levels of acetone and toluene were also detected in soil samples collected from soil borings in Area H. Acetone was detected at a concentration of 0.18 mg/kg at a maximum depth of 20 feet bgs, and toluene was detected at a concentration of 0.015 mg/kg at a maximum depth of 20 feet bgs.

A total of 26 soil gas samples were collected from 19 areal locations. Where possible, two depth intervals were collected in the Central Fill Area. Sample locations and contour maps of reported concentration values for several chlorinated VOCs and TVH are provided in Appendix A. Elevated levels of TVH, 1,1,1-TCA, 1,1-DCE, 1,1-DCA, PCE, and TCE were measured in the northern portion of the Central Fill Area. The concentration contours indicate two general smaller areas (hot spots) within the larger areas of elevated levels. The southeastern portion of the Central Fill Area contained elevated reported values for TVH within the shallow sampling interval. Levels of 1,1,1-TCA and PCE were also reported within the shallow sampling interval. Benzene and other aromatic compounds were not detected. No deep interval samples were collected from this area due to refusal of the sampling probe.

During recent investigations, two additional soil borings which were completed as groundwater monitoring wells (MW-42 and MW-43), and seven additional test pits (TP-267, TP-268, TP-269, TP-270, TP-270, TP-271, and TP-291) were completed in the Central Fill Area of the site. The test pits and one of the groundwater monitoring wells (MW-43) were placed in portions of the Central Fill Area in which elevated levels of VOCs were measured in soil gas samples. The purpose of the additional investigations were to further evaluate Area H as a potential source of groundwater contamination. Soil samples were collected from the soil borings and test pits and analyzed for organic compounds. Ten soil samples were analyzed for diesel range hydrocarbons, seven soil samples were analyzed for VOCs, and three soil samples were analyzed for aromatic compounds.

Stained soils were observed in test pits TP-267, TP-268 and TP-291 below the extent of buried debris to the total depth of the test pits. Diesel range hydrocarbons at concentrations ranging from 200 to 7,000 mg/kg were detected in four of ten samples. All four samples were from P-267, P-268 and P-291 test pits, where the remains of metal drums were found and where stained soils were observed. The aromatic compounds toluene and xylene were detected at 17.0 mg/kg and 14.0 mg/kg, respectively, in one sample collected from 12.5 feet bgs in test pit TP-267. Chlorinated VOCs were not detected in any of the samples analyzed.

As discussed in Section 3.4.2.2, several drums associated with buried debris were excavated from the Central Fill Area during the recent investigations. One drum contained a black viscous petroleum-based material. The material was sampled and a fuel fingerprint of the material completed. The fuel fingerprint indicated the material consisted of Diesel #2, heavy oil and kerosene at levels of 7,800, 95,000 and 18,000 mg/kg, respectively.

In summary, the results of the previous and recent investigations in Area H indicate soils in this portion of the site contain petroleum hydrocarbons at concentrations ranging from non-detect to 76,000 mg/kg. The highest concentration measured at the greatest depth was 13,600 mg/kg at 11.0 feet bgs in TP-218. Elevated levels of hydrocarbons in soil gas are correlatable to elevated levels of hydrocarbons in soil and buried debris containing drums.

5.2.3.7 Area K: Former Transformer Vault Area

The former Transformer Vault Area, Area K (Figure 5), is located in the southern inactive portion of the site, adjacent to the former location of the Main Shop Building. Area K was not extensively investigated previously. However, of five samples collected from shallow soils (0.5 to 2.0 feet bgs) in three test pits in this area, PCBs were detected in all five. Concentrations of PCBs were less than 1 mg/kg in three of the samples, and 7.84 and 5.7 mg/kg in the other two samples. As a result, some additional sampling was conducted recently.

Three additional test pits (TP-262, TP-263, and TP-264) were completed in the former Transformer Vault Area. Stained soils were observed in the all three test pits excavated in this area. Stained soil was observed to range from 4 feet to more than 15.0 feet bgs, the limit of the backhoe utilized for completion of the test pits. Borehole SB-24 was subsequently advanced in this area to assess the vertical extent of stained soil.

A total of seven soil samples were collected and analyzed for diesel range hydrocarbons, and pesticides and PCBs. The maximum level of diesel range hydrocarbons measured in Area K was 380.0 mg/kg at 5.75 feet bgs in TP-262. At 15 feet bgs in test pit TP-162, the diesel range hydrocarbon level was 17.0 mg/kg. Soil samples collected from SB-24 and analyzed for diesel range hydrocarbons were non-detect in 20.0 and 25.0 feet bgs in SB-24. There were no detections of pesticides or PCBs in any of the samples analyzed.

Based on the results of the recent and previous investigations of Area K, it appears that PCBs are restricted laterally and vertically to surface soils in a small region of the site. The highest concentration of PCBs detected was 7.84 mg/kg at 1.5 feet bgs. Diesel range hydrocarbons were detected at a maximum concentration of 380.0 mg.kg at a depth of 5.75 feet bgs, and attenuate with depth to 17.0 mg/kg at 15.0 feet below ground, and non-detect at 20 feet bgs.

5.2.3.8 Previously Unidentified Above-Ground Storage Tank

The area identified as being the previous location of an above-ground storage tank is located in the southern inactive portion of the site, approximately 500 feet north of the former location of the Main Shop Building (Area K, Figure 5). Three exploratory pits (EP-8, EP-9, and EP-10) (samples were not collected from these pits) and one test pit (TP-281) were completed in this area to approximately 5 feet bgs (Figure 29). Stained soils were not observed and PID readings were not above background levels. Inasmuch as there was no indication of hydrocarbons in subsurface soils in this area, no samples were analyzed for hydrocarbons.

5.2.4 Asbestos

The asbestos investigations are described in Section 4.1. Presented in Figure 7 is the location of the former Asbestos Storage Building area of the site, areas where focused excavation and trenching activities were conducted, and soil samples were collected to investigate asbestos contamination in soil.

Soil samples were collected at or near the fill-native soil interface. Soil samples were analyzed by polarized light microscopy (PLM). Asbestos analytical results are presented in Table 1.

The results of the former Asbestos Storage Building area trenching and excavation activities indicate that approximately 1,500 cubic yards of soil in the area of the former Asbestos Storage Building may contain asbestos at concentrations between one and five percent. The asbestos is distributed heterogeneously in the shallow soils from just bgs to approximately 2 feet bgs and consists of asbestos containing building materials, pipe insulation, and lagging material.

Stockpiled soils which were excavated as described in Section 4.1 were subsequently backfilled into the initial excavations on-site in the former Asbestos Storage Building area, per DTSC-approval. The area was subsequently covered by a soil tackifier (Soil Master), applied with a hydroseeding of a thick layer of mulch. A mixture of winter annual and perennial grasses were established over the area.

During the Additional Soil Investigation (Dames & Moore, 1991e), five soil samples were collected and analyzed for asbestos. All five samples were collected from exploratory trenches in buried debris areas of the northern part of the inactive portion of the site. The sample collected from TP-254A, at a depth of 1.5 feet bgs, contained the only detectable levels of asbestos at a concentration of 1%.

5.3 NATURE AND EXTENT OF CONTAMINANTS IN GROUNDWATER

A detailed discussion of the nature and extent of groundwater contamination is presented in the RI/FS Report and the Supplementary Groundwater Investigation Report (Dames & Moore, 1991a). The following discussion on groundwater contamination is intended to augment these previous discussions with chemical analytical results from recent groundwater investigations and quarterly groundwater sampling as discussed in Section 4.0. Monitoring well and CPT/HP locations are presented in Figure 8. Analytical results are summarized in Tables 8 through 10. Comprehensive analytical results are provided in Appendix D, and analytical reports are provided in Appendix F.

5.3.1 Groundwater Analytical Results

5.3.1.1 Metals

Analyses for arsenic, chromium, nickel, and lead were performed for groundwater samples collected from 31 on site wells during the first and second quarter sampling rounds completed during January/February and April/May 1991, respectively. Samples from the initial sampling of new groundwater monitoring wells MW-34, MW-35, MW-39 through MW-43 in July 1991 were also analyzed for these four metals. Summary analytical results are presented in Table 8. A discussion of the analytical results follows.

Arsenic

Arsenic was detected in groundwater samples collected from 17 of 38 monitoring wells. Only two of the 31 wells sampled had detections in samples from both quarterly rounds. The range of measured concentrations was from 5 to 33 μg/l. Arsenic was detected in samples from all four new on-site monitoring wells (MW-40 through MW-43) at low concentrations (5 to 15 μg/l). Arsenic was also detected at 10 μg/l in MW-39, which is the furthest downgradient well. This was the only off-site detection. The federal Maximum Contaminant Limit (MCL) for arsenic in drinking water is 50 μg/l. Background levels for arsenic in Sacramento County, range from 0 to 20 μg/l (Johnson, 1985). Measured levels of arsenic on- and off-site are below the MCL, and generally within the range of background levels.

Chromium (total)

Chromium, as total chromium, was detected in water samples collected from 35 of 38 monitoring wells sampled in 1991. Of the 31 wells sampled during both quarterly rounds, 15 had measurable levels of chromium in both rounds. The range of measured concentrations was from 1.5 to 200 μg/l. The federal MCL for chromium in drinking water is 50 μg/l. Samples obtained from five wells (MW-4, MW-7, MW-11, MW-12 and MW-33) during the January/February 1991 round of sampling, were reported to contain 200 μg/l chromium. These concentrations were all near the reported detection limit of 100 μg/l. The measured concentrations were significantly lower in samples from previous rounds as well as from the April/May 1991 round. Laboratory error associated with the analytical method used during this round and/or sampling methodology may have attributed to these reported concentrations. Subsequent rounds utilizing different analytical methods will be used to further evaluate chromium levels in these wells.

Five of seven new wells sampled contained measurable levels of chromium, ranging from 4 to 17 μg/l. These levels are within the background concentration range of 1 to 20 μg/l, reported for Sacramento County (Johnson, 1985).

Lead

Lead was detected in 8 of 38 wells tested to date in 1991. All detections from quarterly sampling (MW-1 through MW-8, MW-11 through MW-33) came from first quarter samples. Concentrations ranged from 1 to 70 μg/l. Lead was detected in two (MW-39 and MW-42) of the seven new wells sampled following installation, although the levels were low (1 μg/l). The federal MCL for lead in drinking water is 50 μg/l. The first quarter sample from MW-8 was the only sample which exceeded the MCL. Background levels of lead in Sacramento County are < 1 to 9 μg/l (Johnson, 1985).

Nickel

Nickel was detected in water samples collected from 33 of 38 wells. Fifteen of 31 monitoring wells sampled had detections in both rounds. Nickel concentrations ranged from 9.6 to 400 μg/l. In general, measured nickel concentrations were higher for the January/February sampling round then for the April/May sampling round (Table 15). Three of seven recently installed wells contained measurable levels of nickel. There is no federal or state MCL for nickel in drinking water. The State Applied Action Level (AAL) for nickel is 400 μg/l. From the 1991 monitoring well sampling to date, only the January 1991 groundwater sample from MW-23 exceeded the AAL. The reported range of background levels for nickel in Sacramento County is 1.0 to 12 μg/L (Johnson, 1985).

5.3.1.2 Chlorinated VOCs

Analyses for chlorinated VOCs were performed for groundwater samples collected during the first and second quarter monitoring well sampling rounds. Analyses for chlorinated VOCs was performed on water samples from 27 of 31, and 26 of 31 wells sampled during first and second quarterly rounds respectively (Table 9). Samples from the initial sampling of new groundwater monitoring wells MW-34, MW-35, MW-39 through MW-43 were also analyzed for chlorinated VOCs (Table 9). In addition HP-76 through HP-85, collected in February 1991, were analyzed for select chlorinated VOCs (Table 10). A summary of the analytical results follows.

1,1,1-Trichloroethane

1,1,1- TCA was detected in samples from 17 wells, with concentrations ranging from 0.5 to 17 μg/l. Samples from 9 of 12 wells contained measurable levels in both the first and second quarter sampling rounds. 1,1,1-TCA was detected in 5 of the 7 newly installed wells during their initial sampling. All detections were below the EPA MCL of 200 μg/l in drinking water. 1,1,1-TCA was not detected in HP water samples collected in the Central Fill Area.

1,1-Dichloroethane

1,1-DCA was detected in 15 of 27 wells sampled in the first quarter and 15 of 26 sampled in the second quarter. All 15 detections were in the same wells both quarters. Additionally, 1,1-DCA was detected in 5 of 7 samples from newly installed wells, as well as in samples from 4 of 10 HP locations. The concentrations ranged from 1.1 μg/l to 330 μg/l. The highest levels were measured in monitoring well and HP samples taken in the Central Fill area. The state Applied Action Level (AAL) for 1,1-DCA in drinking water is 5 μg/l. No federal or state MCL exists at this time. Of the 24 sampling locations rendering detections, groundwater samples from 15 locations exceeded the MCL for drinking water.

1,2-Dichloroethane

1,2-DCA was detected in samples from 3 of 27 and 3 of 26 monitoring wells in both the first and second quarter, respectively. The highest concentration, 120 μg/l, was detected in a second quarter water sample collected from MW-13. Of the recently installed wells, only the sample collected from MW-39, the furthest downgradient well, had detectable levels of 1,2-DCA (2.9 μg/l). Water samples from the recent upgradient HP investigation contained no measurable levels of 1,2-DCA. The MCL for 1,2-DCA in drinking water is 0.5 μg/l. All detections exceeded the MCL.

1,1-Dichloroethylene

1,1-DCE is the most widely distributed chlorinated VOC constituent measured in groundwater both on- and off-site. 1,1-DCE was detected in water samples from 22 of 27 and 24 of 26 wells analyzed in the first and second quarter, respectively. Detectable levels of 1,1-DCE were measured in 6 of the 7 newly installed monitoring wells. Additionally, 1,1-DCE was detected in HP water samples from 6 of 10 locations upgradient of the former Oil House Area. These detections occurred in the shallow samples only. 1,1-DCE concentrations ranged from 2.9 to 470 μg/l. The state MCL for 1,1-DCE in drinking water is 6 μg/l. Detectable levels from 23 of 35 sampling locations exceeded the MCL.

Trichloroethylene

TCE was detected in water samples from 8 of 27 and 9 of 26 wells analyzed during the first and second sampling rounds of 1991, respectively. TCE was also detected in 4 of the 7 newly installed wells in addition to samples from 3 of the 10 HP locations. Concentrations ranged from 0.89 to 46 μg/l, with the highest concentration measured in the water sample from monitoring well MW-40, screened in the second significant sand zone. The MCL for TCE in drinking water is 5 μg/l. Detectable levels of TCE measured in 7 of 17 samples exceeded the MCL.

Perchloroethylene

PCE was detected at 3.2 μg/l in one groundwater sample collected from well MW-8, in the second quarterly round only. No detections occurred in samples from the new monitoring wells, or the upgradient HP water samples. The MCL for PCE in drinking water (5 μg/l) was not exceeded.

Carbon Tetrachloride

Carbon tetrachloride was detected in only one well, monitoring well MW-29 at 0.68 μg/l, in the second round only. Additionally, carbon tetrachloride was measured in the initial sampling of MW-39 (1.8 μg/l), at the southeast extent of the area of investigation. One sample from the upgradient HP investigation also contained detectable levels of carbon tetrachloride. The MCL for carbon tetrachloride in drinking water is 0.5 μg/l. All detections exceeded this value.

Chloroform

Chloroform was detected in 6 of 27 and 8 of 26 water samples analyzed for chlorinated VOCs in the first and second quarterly round, respectively. Additionally, chloroform was detected in the new well MW-39 at the southeast extent of the investigation area, as well as in one upgradient HP sample. Measured concentrations ranged from 0.57 to 9 μg/l. Chloroform was also detected in field blanks and rinse blanks. Chloroform appears to be present in water as a constituent used for decontamination of public water supply systems (chlorination) and as a potential laboratory contaminant. The MCL for chloroform in drinking water is 200 μg/l. None of the measured levels exceeded this value.

5.3.1.3 Aromatic Hydrocarbons

Analyses for aromatic hydrocarbons were completed on water samples collected from 15 and 12 groundwater monitoring wells sampled during the first and second quarterly rounds respectively. Samples from the initial sampling of new groundwater monitoring wells MW-34, MW-35, MW-39 through MW-43 were also analyzed for aromatic hydrocarbons.

For both sampling rounds, detections of benzene were limited to MW-4 and MW-13, located in the former Oil House Area. The MCL for benzene in drinking water of 1 μg/l was exceeded in the samples from both wells. The highest concentration measured was 10,000 μg/l in the first quarterly round of sampling of MW-13. In at least one of the two sampling rounds toluene, ethylbenzene and xylene were detected in MW-13, and ethylbenzene and xylene were detected in MW-4. Levels of toluene, xylene, and ethylbenzene were all below their respective MCLs for drinking water. Aromatic compounds were not detected in any of the other monitoring wells or in the recently installed monitoring wells.

5.3.4 Distribution of Contaminants in Groundwater

To date, groundwater investigations have assessed the apparent lateral extent of chlorinated VOCs and aromatics in groundwater in the shallow aquifer zone, both on- and off-site. Impacted groundwater from the shallow aquifer zone can be grouped into two different plumes:

- Plume A - Shallow zone aquifer impacted on- and off-site by chlorinated VOCs, and encompassing a smaller plume of aromatic hydrocarbons;

- Plume B - Shallow zone aquifer impacted by low concentrations (near MCLs) of chlorinated VOCs, as well as nickel.

1,1-DCE is the most widely distributed constituent in groundwater both on- and off-site. The lateral distribution of Plume A and Plume B are approximated with concentration contours of 1,1-DCE presented in Figures 30 and 31. Plume A extends from the Central Fill Area, approximately 4,800 feet to the southeast and ranges in width between 250 and 500 feet.

The upgradient limit and potential source area of chlorinated VOCs in groundwater appears to be just south of groundwater monitoring well MW-2 in the Central Fill Area on the inactive portion of the site. Examination of a 1953 aerial photograph indicates the presence of a former surface impoundment just south of MW-2. This feature could potentially be the source of chlorinated VOCs in groundwater. There is the potential for other sources, for example, buried debris containing some drums, within the Central Fill Area which may still be impacting groundwater.

Within the northern portion (700 feet) of the plume, chlorinated VOCs appear to be limited to the upper portion of the shallow aquifer zone sand. Further downgradient, chlorinated VOCs are present at the base of the shallow aquifer zone. In the former Oil House Area, approximately 1500 feet downgradient of the northern extent of the plume, and to the downgradient extent of the shallow aquifer zone sand, higher levels of chlorinated VOCs are generally observed at the base of the shallow aquifer zone sand than in the upper portion.

To the south, where the sand appears to thin and pinches out, the concentrations of chlorinated VOCs in groundwater decrease markedly. At the southern extent of the investigation, low levels (<3 μg/l) of 1,1-DCE, 1,2-DCA and carbon tetrachloride were detected at the location of HP-71 and MW-39.

Additionally, in the former Oil House Area, benzene has been measured at seven to ten parts per million in the upper portion of the shallow aquifer zone. Analytical results from HP and groundwater monitoring well sampling to date indicate that aromatic hydrocarbons in groundwater are restricted to the former Oil House Area and have not migrated off-site.

Associated with the chlorinated VOC Plume A and Plume B are levels of nickel elevated with respect to background. Within Plume B, elevated nickel levels have been measured above the State AAL of 400 μg/l.

The vertical extent of contaminated groundwater has undergone further evaluation, but is not yet complete. Chlorinated VOCs have been detected in groundwater samples from wells MW-12, MW-28 and MW-40, screened across the next lower (second) significant sand zone (hydrostratigraphic unit). The highest levels of chlorinated VOCs were detected in MW-40, which appears to be the furthest downgradient of the three deeper wells. Well MW-41, screened in a lower (third) significant sand zone, adjacent to MW-12, did not contain detectable levels of chlorinated VOCs in the initial groundwater sample. This indicates that the vertical extent of chlorinated VOCs in groundwater is confined to the upper two sand zones (hydrostratigraphic units) in the former Oil House Area.

5.4 REVISED BASELINE HEALTH RISK ASSESSMENT

The results of the Revised Baseline HRA are summarized in Table 11. Total estimated lifetime cancer risks (i.e. summed for all exposure pathways and all carcinogenic chemicals) for current land use intruder and off-site resident exposure scenarios ranged from 2.0×10^{-4} to 1.4×10^{-3}. Estimated exposures to arsenic provided the greatest contributions to estimated cancer risks. The inhalation and fruit and vegetable ingestion pathway, from produce obtained from a backyard garden, were the major exposure pathways for off-site residents. Soil ingestion and inhalation with soil were the major exposure pathways for trespassers on the site.

Total estimated lifetime cancer risks for future land use off- and on-site resident exposure scenarios ranged from 9.2×10^{-4} to 1.7×10^{-2}. The greatest contributors to estimated cancer risks were arsenic in soil, and 1,1-DCE and benzene in groundwater. Potential non-cancer effects were of concern for antimony, arsenic, copper, zinc, thallium and naphthalene in soil in the on-site resident exposure scenario. The groundwater exposure pathway represented a major contributor to estimated health risks. However, since concentrations of VOCs in groundwater exceed drinking water standards, it is unlikely that groundwater would be used for domestic purposes without remediation. Therefore, inclusion of the groundwater exposure pathway overestimates total cancer risk.

Exposures to lead in the trespasser and off-site resident scenarios resulted in geometric mean blood-lead levels of 5.61 and 3.32 ug/dL, respectively. In the trespasser scenario, fewer than 1 percent of individuals potentially exposed through this scenario would exceed an acceptable blood-lead level of 10 ug/dL. In the off-site resident scenario, fewer than 5 percent of individuals potentially exposed through this scenario would exceed a blood-lead level of 10 ug/dL. Exposures to lead in the on-site resident scenario resulted in a geometric mean blood-lead level of 6.75 ug/dL. In the on-site resident scenario, 13 percent of individuals exposed through this scenario would exceed a blood-lead level of 10 ug/dL.

5.5 SUMMARY AND CONCLUSIONS

5.5.1 Summary

Presented in this section is a summary of the results of supplementary remedial investigations completed since submittal of the draft RI/FS Report in August 1990. The understanding of the site characteristics and contaminant distribution in site soils and groundwater has been changed to reflect the results of the supplementary investigation.

The site has been referred to as the active (western) portion, and inactive (eastern) portion. The eastern portion of the site was the area where the majority of railroad maintenance activities were conducted historically, from about 1910 or 1911 to 1984. Railroad maintenance activities have not been conducted at the site since about 1983. The western portion of the site is the switching area of the site and remains active for switching cars between trains.

The soil and groundwater investigations have been concentrated in the eastern inactive portion of the site, because that is the area where the railroad industrial maintenance activities, which may have involved the use of hazardous substances, were predominantly conducted.

5.5.1.1 Geology

Additional investigations of on-site soils have been completed by evaluating the data generated from 62 exploratory borings, 38 of which were completed as groundwater monitoring wells, over 300 test pits, and completion of 76 CPT lithologic holes during several additional supplementary investigations (Figures 8 and 9). The soils data generated during the supplementary investigations include lithologic logs and cross sections, and have been incorporated into the previous RI data to provide a comprehensive evaluation of the eastern inactive portion of the site.

As discussed in the RI/FS Report, the UPRR Yard, Sacramento, California site is situated above a sequence of fluvial clay, silt, and sand deposits. A schematic subsurface cross-section is included as Figure 12.

Most of the surface of the inactive portion of the site is covered by heterogeneous fill material, approximately 1 to 10 feet in thickness, consisting of soil, building demolition debris, and a wide range of other substances. Fill material is thickest in the central area of the inactive portion of the site.

Underlying the fill is an overall upward fining sequence of fluvial fine to medium sands, silts and clays, which has been interpreted to represent part of the Pleistocene Victor Formation. At the top of this sequence is a well developed soil horizon which generally contains a hardpan layer of low permeability.

Underlying the soil horizon, in general, are clayey silts and silty clays, which overlie interbedded sands, silts and clays. The base of the fining upward sequence is formed by a fine- to medium-grained sand which in itself fines upwards and contains occasional pebble and fine gravel lenses towards its base. This sand is of variable thickness and lithology, is lenticular in shape, and occurs between approximately 30 and 65 feet bgs. This sand zone represents the pertinent shallow hydrogeologic feature (shallow aquifer zone) on-site. The base of this sand is formed by an erosional surface on clay to silty clay. The general characteristics and geometry of this sand unit indicate a river channel sand. The regular fining upward grain size sequences and sedimentary structures are correlative with a meandering channel.

The channel axis appears mainly to trend southeast-northwest across the southern portion of the site, into the southwestern Curtis Park residential area, and thins and pinches out across Sutterville Road to the southeast (See Figures 30 and 31). Very little data are available for the northern part of the inactive portion of the site. However, the sand appears to be thickest in the northern part of the inactive portion of the site, and is not present in the northeast part of the site.

The basis for the interpretation of deeper stratigraphy underlying the shallow aquifer zone sand is lithologic logs from six exploratory borings, four of which were geophysically logged. A zone of clay and silty clay 10 to 20 feet thick underlies the fine to medium sand (shallow aquifer zone) of the fining upward sequence. Beneath the clay and silty clay is an interbedded zone of sands, silts and clays, extending to a depth of at least 150 feet bgs. Occasional thin sand units, between 95 and 135 feet bgs are traceable between the deep borings.

5.5.1.2 Hydrogeology

Beneath the site, the uppermost water-bearing zone (shallow aquifer zone) occurs in the fining upward fluvial sands, silts and clays. The shallow aquifer is the fine- to medium-grained channel sand referred to above which occurs between approximately 30 and 65 feet bgs. It is unconfined, although it extends up into overlying finer grained silts and silty sands. The shallow aquifer zone appears to thin and fine laterally to interbedded clay, silt and fine sand to the south, southeast, northeast, and west.

Based on water elevations measured in site monitoring wells, the horizontal hydraulic gradient of groundwater in the shallow aquifer zone is approximately 0.002. Groundwater flow direction varies across the site, from primarily due south in the northern portion, to southeast in the southern portion of the site. Gradient and flow direction across the site appear to be influenced by the subsurface channel sands and the general south and southwest soil fining trends of the shallow aquifer zone, although the more easterly component of flow suggests other local influences as well. Flow direction and gradient could potentially be influenced locally by pumping downgradient, as well as by local stratigraphic changes.

Off-site downgradient water level information is limited to three wells at two geographic locations. The water level data from these three off-site wells indicate a gradient similar to that observed on-site.

Slug test results indicate that the transmissivity ranges from 9 to 160 m^2/day or 100 to 1,800 ft^2/day and does not vary much in the shallow aquifer throughout the on-site investigation area. For the ten shallow zone wells tested, calculated hydraulic conductivities ranged from 2.1×10^{-2} to 1.2×10^{-3} cm/sec. These values are higher by an order of magnitude than laboratory determined permeability values. Using calculated hydraulic conductivities and a range of porosity of 36 to 41 percent, the average groundwater velocity is 5.0×10^{-3} to 1.5×10^{-1} m/day or 0.017 to 0.5 ft/day.

Underlying the shallow aquifer zone is a shallow aquitard composed principally of clay and silty clay with minor amounts of sand and silt, and some limited beds of silty sands. Information available on this zone is limited, but generally the clay to silt and sand proportion seems to decrease towards the base of this zone. The clay and silty clay deposits appear to occur as a continuous unit across the site, but decrease in thickness from south to north, from about 20 feet to 10 feet.

Underlying the shallow aquitard is a number of discontinuous and continuous aquifer units (lower aquifer zones) which appear to be confined or semi-confined. The deep aquifer zones consist of fine sands interbedded with silts and clays of varying thickness and lateral distribution. On the basis of lithologic and geophysical logs, these zones appear to be continuous and correlatable sand units. Hydraulic information for these deep aquifer zones is limited as only three deep wells monitor the top silty sand unit within this zone, and one deep well monitors a lower sand. However, differential water level measurements in adjacent wells in the shallow and deeper aquifer zones indicate a downward vertical hydraulic gradient exists between these zones.

5.5.1.3 Nature and Extent of Contamination

Soils Investigation

The results of the supplementary investigations and the RI indicated three major categories of contaminants are present in site soils: metals (particularly arsenic and lead), petroleum hydrocarbons (with the exception of the former Oil House Area, primarily diesel), and asbestos. PAHs, several aromatic compounds, and chlorinated VOCs were detected, but at relatively low levels in soil samples.

Sampling and analytical data indicate that metal constituents appear limited to specific areas across the site. Elevated concentrations of metals appear centered in the operations area in the southern portion of the inactive portion of the site. The origin of the metals may include such activities as: sand blasting of railcars, machining operations, production and use of babbitted bearings and brake linings, painting operations, uses of wood preservatives, pesticides and herbicides, and chemical storage practices. Additionally, recent data suggest that slag applied as track ballast is at least one of the sources of metals at the site. The slag is primarily distributed in linear form, along the former location of tracks in the inactive eastern portion of the site, and along some of the active tracks in the active western portion of the site. The following is a summary of the soils metals investigation results:

- Approximately 23 acres of the surface of the inactive portion of the site appear to have been impacted by arsenic and lead;

- With the exception of the northwest corner of the inactive portion of the site, elevated levels of arsenic and lead in shallow soils (less than 1.5 feet bgs) are primarily found in the former maintenance areas of the site and appear to be an artifact of lead- and arsenic-containing materials commonly associated with railroad equipment, railroad yard activities, and slag ballast;

- There is no known source for elevated levels of arsenic and lead in the northwest corner of the inactive portion of the site, but application of herbicides in this area or slag ballast are possibilities;

- Below a depth of 2.0 feet bgs, elevated levels of arsenic and lead appear primarily associated with fill materials located in the central portion of the inactive portion of the site; and

- Below the fill materials, levels of arsenic and lead were not significantly elevated. Slag containing arsenic and lead is of very low, if not negligible, solubility, as demonstrated by the results of the focused analysis of samples collected one to two feet beneath slag.

Results of the supplementary investigations and RI suggest diesel range petroleum hydrocarbons are the primary organic constituents in soils in the inactive eastern portion of the site. Speciation of the hydrocarbons indicates that, with the exception of the former Oil House Area of the site, gasoline fuel is not a significant hydrocarbon present in soils.

Petroleum hydrocarbons were detected in eleven general areas of the inactive portion of the site. In general, it appears that petroleum hydrocarbons are restricted to the shallow fill soils. The exception to this may be the former Oil House Area (Area F), and the Central Fill Area (Area H) where petroleum hydrocarbons, and aromatic and chlorinated VOCs may have leached through soils to groundwater. Although hydrocarbons have penetrated shallow soils in the 1,000-Gallon UST Area (Area B) and the former Transformer Vault Area (Area K), based on the available data, the hydrocarbon levels attenuate rapidly with depth and should not be considered significant.

Asbestos has been detected at depths between 1 and 3 feet bgs at concentrations between 1 and 5 percent in the southwestern corner of the inactive portion of the site. This is the former area of the Asbestos Storage Building.

Low levels (<1 to 7.8 ppm) of PCBs were detected in Area K. Sampling during the supplementary investigations of Area K indicates that PCBs are restricted to surficial soils.

Air Investigation

The air monitoring investigation was conducted during the RI by placing three high volume air samplers in the area of the site, one upwind and two downwind based on ambient wind conditions. Samples were collected on glass fiber filters and analyzed for asbestos, arsenic, copper, lead, and total particulates. Based on the results obtained, there is no impairment at the site from these constituents.

Groundwater Investigation

To assess the vertical and lateral extent of groundwater contamination, 35 monitoring wells have been installed in the inactive portion of the site. Most of these wells are completed in the shallow aquifer zone. Five wells are completed in deeper zones.

Data on the vertical and lateral extent of chemical constituents in shallow groundwater were obtained both on- and off-site during supplementary groundwater investigations which utilized CPT and HP sampling techniques. A total of 76 CPTs were completed and HP samples were generally collected at two depths at each of 85 locations in the shallow aquifer zone.

Additional groundwater investigations have included the installation of three groundwater monitoring wells off-site, and three additional off-site groundwater monitoring wells are planned for November 1991.

Groundwater samples were collected from monitoring wells in accordance with appropriate sampling procedures and protocol. Groundwater samples have been analyzed for CCR metals, chlorinated VOCs, purgeable aromatics, TPH, gasoline range TPH, PAHs, pesticides and PCBs.

Groundwater samples collected from HP samples were analyzed for chlorinated VOCs, and, in some cases, for aromatic compounds. Analysis for aromatic compounds was generally limited to the area proximal to and downgradient of the former Oil House Area of the site.

Measured concentrations of arsenic, barium, cadmium, chromium, cobalt, copper, lead mercury, molybdenum, silver, vanadium, and zinc indicate these metals are present at levels generally reflecting natural background levels in groundwater, and do not approach or exceed any existing federal or state drinking water standard. Chromium and lead have been measured with inconsistency in some wells at concentrations above background, and in some cases, above MCLs. Further evaluation is required to assess the extent of chromium and lead and groundwater.

Neither PAHs, pesticides, nor PCBs were detected in any water samples collected from site monitoring wells.

Aromatic and chlorinated VOCs were detected in groundwater samples collected from on-site monitoring wells and from several HP locations both on- and off-site. The previous off-site detections of aromatic compounds were at or near the MCLs. In the last two sampling rounds, aromatic compounds were not detected in samples collected from groundwater monitoring wells downgradient of the former Oil House Area of the site. The aromatic compounds benzene, toluene, xylene, and ethylbenzene were detected at significant concentrations only in groundwater monitoring wells and HP samples in the former Oil House Area of the site.

The chlorinated VOCs 1,1-DCE, 1,1-DCA, 1,2-DCA, 1,1,1-TCA, TCE, PCE, and carbon tetrachloride were detected in groundwater monitoring wells and HP samples collected from the inactive portion of the site and off-site in the shallow aquifer zone, as well as a deeper aquifer zone. The evaluation of the lateral and vertical extent of chlorinated VOCs has been completed in the shallow aquifer zone. The source of the shallow aquifer zone groundwater plume appears to be the Central Fill Area of the site, and the plume width varies from approximately 250 to 500 feet, and extends approximately 4,800 feet to the southeast to 18th Avenue.

The extent of the chlorinated VOCs in the deeper aquifer zones has not been fully evaluated. The deepest groundwater monitoring well installed on-site (MW-41 in the former Oil House Area) is screened at a depth of 104.5 to 114.5 feet bgs and chlorinated VOCs have not been detected in this well. The deepest groundwater monitoring well furthest downgradient of the Central Fill Area (MW-40) is screened between 73 and 83 feet bgs, and chlorinated VOCs were measured in this well at a concentration equivalent to the levels detected in the adjacent shallow aquifer zone well (MW-32).

Chlorinated VOCs have also been detected in the southeastern part of the inactive eastern portion of the site. Most of the detections in this area of the site are at or near the MCLs for the contaminants.

5.5.2 Conclusions

There have been five major categories of contaminants found in soil and groundwater at the UPRR Sacramento site:

(1) Metals;

(2) Petroleum Hydrocarbons, primarily diesel range;

(3) VOCs;

(4) PCBs; and

(5) Asbestos.

Each of these categories of contaminants could potentially require different mitigation strategies. Although two potential geographic sources of groundwater contamination were identified (the former Oil House Area for aromatic compounds and the Central Fill Area for chlorinated VOCs), significantly elevated levels of the VOCs in soil as would be anticipated with an existing groundwater contaminant source were not measured. Since a clear correlation between soil and groundwater contamination is not demonstrated, separate mitigation strategies of the soil and groundwater will be developed. The mitigation strategies are the focus of the Supplementary Feasibility Study (Section 6.0).

6.0 SUPPLEMENTARY FEASIBILITY STUDY

6.1 INTRODUCTION

The performance of additional investigative activities subsequent to completion of the RI/FS Report for the UPRR site generated new data relative to the nature and extent of site-specific contamination. Evaluation of this data shows that revision of the identification and evaluation of remedial technologies and alternatives included in Volume 2 (Feasibility Study) of the RI/FS Report is merited for three reasons.

First, the new data shows that the development of new and/or reconfigured remedial action objectives (RAOs), operable units and remedial alternatives is necessary. New RAOs are needed because additional knowledge has been gained regarding the type and concentration of contaminants (especially contaminants of concern), exposed populations, and exposure pathways. Thus, development of new remediation targets, in the form of RAOs is essential. New and/or revised operable units are needed because new information about the distribution of contaminants has altered the strategy regarding the type and scope of remediation which may be appropriate for different areas of the site. New and/or revised remedial alternatives are needed because the previously existing alternatives do not adequately address all of the contaminants of concern which are identified by new data, nor do they adequately address new RAOs and/or new operable units.

Second, the new data shows that a re-evaluation of alternative screening and analysis is required. A re-evaluation of the alternative screening which was previously conducted is necessary because changes in the size and composition of operable units as well as in the type and/or quantity of contaminants and contaminated media influences the ability of alternatives to satisfy the three screening criteria of effectiveness, implementability and cost. As a result, it may be appropriate now to screen out or eliminate alternatives which were previously retained. A re-evaluation of the detailed analysis of alternatives which was previously conducted is necessary because the ability of new alternatives to protect human health and the environment, receive State and community acceptance, comply with Applicable or Relevant and Appropriate Requirements (ARARs), etc., may be different for the new operable units than it was for previously existing operable units.

Finally, the new data shows that a new and/or revised summary and comparison of alternatives, and the selection of one or more recommended remedial alternatives is required. This is because the relative advantages and disadvantages of new and/or revised alternatives as they apply to the new RAOs and operable units is different than for the previously existing alternatives. In addition, the larger and more complete data set which is now available makes it possible to more effectively select one or more recommended remedial alternatives based on the nine evaluation criteria which are recommended for use by the U.S. Environmental Protection Agency (EPA).

All of these changes to the Feasibility Study are described in greater detail below. It is the intent of this section to conform as closely as possible to the format of the Feasibility Study as presented in the RI/FS Report, and at the same time comply with Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988).

6.2 REMEDIAL ACTION OBJECTIVES (RAOs)

Remedial action objectives (RAOs) are medium-specific or operable unit-specific goals for protecting human health and the environment. RAOs should specify the contaminants of concern, the exposure route(s) and receptor(s), and an acceptable concentration or range of concentrations in each affected medium (in this case, soil or groundwater). RAOs should specify both an acceptable concentration of contaminant and an exposure route, rather than a concentration alone, because protection of health and the environment may be achieved by preventing or reducing exposure (i.e. capping an area or limiting access through a deed restriction or fencing) as well as reducing the contaminant concentrations. Determination of the contaminant concentrations in each medium used as RAOs include consideration of background concentrations, the significant exposure pathways identified in the Baseline Health Risk Assessment and the risks associated with implementing each alternative. Selection of RAOs for the UPRR Sacramento site includes consideration of the following factors:

- RAOs for carcinogenic chemicals should fall below an increased lifetime cancer risk of 10^{-6} (DTSC, 1990);
- RAOs for non-carcinogenic substances should fall below their respective Applied Action Level (AAL) or Reference Dose (RfD); and
- An RAO for lead should fall below a blood-lead level of 10 ug/dL.

6.2.1 Identification of Chemicals and Pathways of Concern

The results of the Baseline Health Risk Assessment, presented in Appendix J, have been used to identify the chemicals and exposure pathways of concern. RAOs have been developed for these chemicals and exposure pathways. Selection of the chemicals and exposure pathways of concern in soil also considered the distribution of the chemicals in the soil. Chemicals with widespread distribution in soil were selected because remedial actions that achieve RAOs for these chemicals are also expected to reduce risks from chemicals with discrete distribution in the soil.

The Baseline Health Risk Assessment evaluated seven exposure scenarios with increased lifetime cancer risks ranging from 9×10^{-5} to 7×10^{-3}. In the exposure scenarios evaluating off-site residents, inhalation of arsenic in wind-blown dust provided the primary contribution to the estimated risk. In these exposure scenarios, inhalation of arsenic accounted for over 97 percent of the total cancer risk associated with chemicals detected at the site. Exposures to non-carcinogenic chemicals did not exceed the respective AALs or RfDs in the current land use scenarios.

Future land use scenarios evaluated health risks of off-site residents and hypothetical on-site residents. The principal exposure pathways associated with future off-site residents were inhalation of chemicals in wind-blown dust and ingestion of chemicals in off-site groundwater. In the exposure scenarios evaluating future off-site residents, inhalation of arsenic accounted for 10 percent of the total risk, while ingestion of 1,1-dichloroethene in groundwater accounted for some 83 percent of the total risk. Ingestion of 1,1-dichloroethane and 1,2-dichloroethane in groundwater accounted for four percent of the total risk. In evaluating the risk associated with 1,1-dichloroethene, it should be noted that this chemical is listed as a possible human carcinogen (Class C). Very limited evidence is available suggesting that 1,1-dichloroethene or 1,1-dichloroethane are carcinogenic. Exposures to non-carcinogenic chemicals did not exceed the respective AALs or RfDs for these scenarios.

In the exposure scenarios evaluating hypothetical future on-site residents, ingestion of arsenic in groundwater accounted for 14 percent of the total risk; ingestion of 1,1-dichloroethene accounted for 39 percent of the total risk; and, ingestion of benzene in groundwater accounted for 21 percent of the total risk. Direct contact with arsenic in soil (i.e. soil ingestion and dermal contact with soil) accounted for less than five percent of the total risk. Inhalation of 1,1-dichloroethene volatilized from water during showering accounted for approximately six percent of the total risk. Arsenic, 1,1-dichloroethene and benzene (from all exposure pathways) accounted for approximately 90 percent of the total risk. Ingestion of these three chemicals in groundwater accounted for approximately 74 percent of the total risk. Exposures to non-carcinogenic chemicals antimony, barium, cadmium (through the ingestion pathway), copper, thallium, zinc and non-carcinogenic polycyclic aromatic hydrocarbons (PAHs) exceeded the AALs or RfDs in these scenarios.

Lead detected in soil and groundwater at the site was evaluated in terms of target blood-lead levels. The U.S. Centers for Disease Control (CDC) and DTSC have recommended a target blood-lead level of 10 ug/dL. A concentration of 477 mg/kg in soil (the upper confidence limit, or UCL, of the site-wide average concentration in soil) was associated with a geometric mean blood-lead level of 5.58 ug/dL. Fewer than five percent of individuals potentially exposed to this concentration in soil would be expected to have a blood-lead level that exceeded 10 ug/dL. However, areas of the site have locally elevated concentrations of lead in soil. The geometric mean blood-lead level for the area with the highest locally elevated concentration, an UCL concentration of 1,899 mg/kg in soil, was 18.04 ug/dL. Over 95 percent of individuals potentially exposed to this localized "hot spot" would be expected to have blood-lead levels that exceeded 10 ug/dL.

Petroleum hydrocarbons (measured as Total Petroleum Hydrocarbons or TPH) were detected in soil in several areas of the site. Toxicity values for evaluating health risks associated with TPH are not available. A significant portion of the health risks from potential exposure to petroleum hydrocarbons are considered to be associated with the PAH fraction. Therefore, evaluation of health risks associated with TPH was based on the concentrations of PAHs found in the soil at the site.

Based on the results of the Baseline Health Risk Assessment, the combinations of chemicals and exposure pathways that are of concern, and that require development of RAOs are:

- Inhalation of arsenic in wind-blown dust, ingestion of arsenic in on-site groundwater and direct contact with arsenic in surface soils;
- Direct contact with lead in surface soils;
- Direct contact with carcinogenic and non-carcinogenic PAHs (which are assumed to represent TPH) in soil; and
- Ingestion of benzene and chlorinated VOCs, particularly 1,1-dichloroethene, 1,1-dichloroethane and 1,2-dichloroethane in groundwater.

The potential for constituents of TPH in soil to migrate to groundwater was evaluated in the RI/FS Addendum. RAOs for TPH were also based on the potential for these constituents to migrate to groundwater. An interim remedial measure (IRM) for asbestos in soil has been undertaken at the site. The RAO for asbestos in soil has also been presented in this section.

6.2.3 Development of Remedial Action Objectives

Risk-based residual concentrations in soil and groundwater were calculated using the methodology and assumptions developed in the Baseline Health Risk Assessment. Instead of calculating risk from measured concentrations at the site, the intake equations presented in the Baseline Risk Assessment are rearranged to calculate risk-based concentrations of chemicals in soil and groundwater from pre-selected risk. Residual concentrations in soil associated with 1 x 10^{-6} lifetime cancer risk are calculated for arsenic in soil, and benzene and chlorinated VOCs in groundwater. Residual concentrations of lead in soil were calculated based on maintaining blood-lead levels at or below 10 ug/dL. Note that remedial action alternatives that involve capping or covering soil in areas of the site reduce risks associated with wind-blown dust and reduce the potential for exposure through direct contact with soil. Alternatives that involve institutional controls on groundwater use also prevent exposure through groundwater exposure pathways.

6.2.3.1 Soil

The Feasibility Study identified RAOs for arsenic, lead and TPH. To this list have been added asbestos and PAHs. The RAOs for soil are shown in Tables 12 and 13. The RAOs for arsenic and lead have not changed. The RAO for arsenic is equivalent to background concentrations. The RAOs for lead and PAHs are based on the results of the health risk assessment. The RAO for asbestos is based on the California Occupational Safety and Health Administration (OSHA) standard for the safe protection of employees exposed to asbestos in the workplace.

Arsenic was detected in 310 of 315 surface soil samples (0 to 0.5 foot), while lead was detected in 307 of 317 surface soil samples. Therefore, RAOs that reduce risks associated with arsenic and lead are likely to reduce risks associated with other metals with a more limited distribution in the soil.

The RAOs for soil are presented in Table 12. The arsenic concentration in soil equivalent to a 10^{-6} risk was 0.044 mg/kg. However, the regional average background concentration in soil has been shown to be 8 mg/kg. Since reduction of arsenic concentrations in soil to below background would not be feasible, the RAO for arsenic is the background concentration, or 8 mg/kg. The RAO for lead in soil is 190 mg/kg. This concentration is associated with a geometric mean blood-lead level of 3.32 ug/dL. The California Department of Health Services recently has estimated that fewer than 14 percent of children tested for blood-levels had levels exceeding ten μg/dL. This suggests that the median (i.e. 50 percent level) is well below ten μg/dL. The RAO for lead is based on achieving a blood-lead level of less than 10 ug/dL both from lead in the soil at the site and from background sources of lead. Residual concentrations of TPH in soil were based on the potential for TPH constituents to migrate to groundwater. A leachability study was performed to estimate the potential for naphthalene, the most mobile constituent of TPH in soil, to migrate to groundwater. The concentration of TPH in soil associated with the AAL for naphthalene (20 ug/L) in groundwater was estimated from this leachability study. The results from this study are presented in Table 13. The leachability study is presented in Appendix I.

The Feasibility Study also identified "hot spots" for arsenic and lead. These areas contain the highest concentrations of these contaminants. These areas represent the highest potential health risk on the site, and elimination of the potential for exposure to these areas will significantly reduce the risk.

In addition to the hot spots originally identified for metals, this Addendum identifies hot spots for TPH. The concentration of TPH hot spots is greater than or equal to 15,000 mg/kg in soil. This concentration represents the level at which petroleum hydrocarbons may move freely in soil without consideration of infiltration (Appendix I). These areas represent a potential source of groundwater contamination.

The volume of contaminated soil in hot spot areas is listed in Table 15. The location of hot spots are shown on Figures 38 through 45.

6.2.3.2 Groundwater

The Feasibility Study identified RAOs for groundwater contaminants that are equivalent to promulgated ARARs (i.e., DHS applied action levels or MCLs). These have not changed and are shown in Table 14.

Risk-based concentrations in groundwater were calculated for arsenic, benzene, 1,1-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, trichloroethene and ethylbenzene. State Maximum Contaminant Limits (MCLs) are available for all of these chemicals, except for ethylbenzene. This MCL takes into account the detection limit for this chemical in water, as well as the level in water that can be achieved with the best available control technology. While the risk-based concentrations for these chemicals in groundwater are lower than the MCLs, the MCLs were chosen as RAOs based on these considerations of detection limits and control technologies. An AAL is available for ethylbenzene, and was chosen for the RAO.

The Feasibility Study did not identify hot spots for groundwater. Furthermore, no hot spots for groundwater have been identified in this Addendum RI/FS.

6.3 OPERABLE UNITS AND VOLUMES

An operable unit is defined as any contaminated area or media of concern which, because of unique chemical and/or physical characteristics, requires special remediation techniques and/or affords the opportunity for more expeditious and/or cost-effective remedial action if addressed separately during site clean-up. In the RI/FS Report (Dames & Moore, 1991f), three operable units were identified for soil and two operable units were identified for groundwater. Generation of additional site characterization data since completion of the RI/FS Report indicates that there is a need to reevaluate these operable units and establish new operable units for the purpose of facilitating site remediation. The following sections describe the new operable units which have been established for the site.

6.3.1 Soil Operable Units and Volumes

Upon an examination of new data describing the nature and extent of contamination, five separate operable units have been established for soil. These operable units are different than those established in the RI/FS Report. They include:

- Operable Unit S-1 — Arsenic, Lead, TPH, Asbestos (Inactive Portion of Site);
- Operable Unit S-2 — Arsenic, Lead, and TPH (Central Fill Area-Inactive Portion of Site);
- Operable Unit S-3 — Arsenic, Lead, and TPH (Northernmost Inactive Portion of Site);
- Operable Unit S-4 — Arsenic and Lead (Off-site Contamination); and
- Operable Unit S-5 — Arsenic, Lead, and TPH (Active Portion of Site).

Operable units are identified as those areas of the site where the concentration of the contaminants of concern exceed RAOs (see Section 6.2). Figures 32 through 36 show the location of operable units S-1, S-2, S-3 and S-4. Operable unit S-5 lies within the bounds of the active portion of the site shown in Figure 2. Figures 16 through 23 and 38 through 41 show the concentration contours at varying depth intervals which represent soil contamination in excess of RAOs for lead, arsenic and TPH for S-1, S-2, S-3, and S-4. Presented in Figures 38 through 45 are the locations of hot spots at varying depth intervals for S-1, S-2, and S-3 (note that all TPH hot spots are located in S-2). Each of the five new operable units for soil is described in greater detail below.

6.3.1.1 Soil Operable Unit S-1

The contaminants of concern in this operable unit are arsenic, lead, TPH, PAHs, and asbestos. S-1 contains soils with concentrations of arsenic and lead which exceed 8 mg/kg and 190 mg/kg respectively, concentrations of TPH which exceed the depth-dependent RAOs presented in Table 13 and described in Appendix I, concentrations of PAHs which exceed the health risk-based RAOs on Table 12, and material which is composed of greater than 1 percent by volume asbestos. The area of S-1 is estimated to be 1,143,300 square feet or roughly 27 acres and the total in situ volume is estimated to be 94,700 cubic yards of soil (Table 15).

6.3.1.2 Soil Operable Unit S-2

The materials or contaminants of concern in this operable unit are arsenic, lead, TPH, and PAHs in soil above RAOs, and buried debris containing drums. Additionally, S-2 contains TPH hot spots in S-1 and S-3. Evidence indicates that the buried drums may be a potential source of groundwater contamination. The area of S-2 which current data suggest will require remediation is estimated to be 246,800 square feet, or roughly 6 acres and the total in situ volume is estimated to be 48,200 cubic yards of soil (Table 15). This estimate does not include debris (including drums) which is buried in this area. Additional investigations will be required as part of the implementation of any recommended remedial alternative for S-2 in order to better define the extent and volume of contaminated soil and/or debris contained in S-2.

6.3.1.3 Soil Operable Unit S-3

The materials or contaminants of concern in this operable unit are arsenic, lead, and TPH. S-3 contains only soils with concentrations of arsenic and lead which exceed 8 mg/kg and 190 mg/kg respectively, and TPH which exceed the depth-dependent RAOs presented in Table 13. The area of S-3 is estimated to be 206,600 square feet or roughly 5 acres and the total in situ volume is estimated to be 16,900 cubic yards of soil (Table 15).

6.3.1.4 Soil Operable Unit S-4

The materials or contaminants of concern in this operable unit are arsenic and lead. S-4 contains soils with concentrations of arsenic and lead which exceed 8 mg/kg and 190 mg/kg, respectively. No elevated concentrations of PAHs, asbestos or TPH has been found in this area. The area of S-4 is estimated to be 9,550 square feet or roughly 0.2 acres and the total in situ volume is estimated to be 600 cubic yards of soil (Table 14).

6.3.1.5 Soil Operable Unit S-5

The materials or contaminants of concern which have been identified in this operable unit are arsenic, lead, and TPH. S-5 has not been fully characterized. Therefore, the areal extent and volume of contaminated soil in this operable unit is currently unknown. Additional soil sampling and analyses are planned to be completed in S-5 in the near future. Analysis of the feasibility of appropriate remedial alternatives for S-5 will not be completed in this document, but will be provided in a separate document.

6.3.2 Groundwater Operable Units and Volumes

Upon the examination of the new data which address the nature and extent of contamination, two operable units have been identified for groundwater. These operable units are similar to those established in the RI/FS Report. They include:

- Operable Unit GW-1 — Chlorinated solvents (upper and deeper aquifer zones) in the southeast portion of the site and off-site to the southeast, and aromatic compounds (upper aquifer zone only) in the Former Oil House Area of the site.
- Operable Unit GW-2 — Chlorinated solvents and nickel (upper aquifer zone only) in the southeast portion of the site at levels very near the MCLs.

Groundwater operable units and volumes are identified as those areas where the concentration of the contaminants of concern exceed RAOs (Section 6.2). In general, GW-1 corresponds with Plumes A, B, and D in the RI/FS Report and GW-2 corresponds with Plumes C and E. The extent of these operable units is summarized in Table 16 and shown on Figure 37. They are described in greater detail below.

6.3.2.1 Groundwater Operable Unit GW-1

The contaminants of concern in this operable unit include chlorinated solvents (i.e., 1,1,1-TCA; 1,1-DCA; 1,2-DCA; 1,1-DCE; and TCE) and aromatic hydrocarbons. GW-1 has an estimated areal extent of about 1,540,000 square feet (35.4 acres) and a total estimated volume of approximately 19,400,000 cubic feet (145,000,000 gallons). This assumes that the volume of contaminated water above RAOs in the deep aquifer (currently undefined) is the same as the volume of water in the upper aquifer. The volume of water in the upper aquifer zone is estimated to be approximately 9.7×10^6 cubic feet, based on an assumed thickness of approximately 20 to 35 feet and a porosity of 25 to 30 percent.

6.3.2.2 Groundwater Operable Unit GW-2

The contaminants of concern in this operable unit include nickel and chlorinated solvents. GW-2 has an estimated areal extent of about 197,000 square feet (4.5 acres). The volume of GW-2 is estimated to be approximately 890,000 cubic feet (6,650,000 gallons). This estimate is based on the aerial extent of GW-2 as shown on Figure 37, an assumed thickness of 15 feet, and a porosity of 30 percent.

6.4 DEVELOPMENT OF ALTERNATIVES

6.4.1 Development of Soil Alternatives

Initially nine soil alternatives were developed in Section 3.1 of the Feasibility Study of the RI/FS Report. These include no action, limited action, and a range of treatment alternatives. The nine alternatives, and one new alternative, are described below and reevaluated based on the current understanding of the nature and extent of soil contamination. The purpose of this work is to determine whether some of the remedial technologies which are included in each alternative should be deleted, reconfigured, or supplemented, and/or evaluate the potential applicability of alternatives relative to the new soil operable units. The results of this work are shown in Table 17.

6.4.1.1 Alternative 1: No Action

This alternative would leave the site in its present condition and would apply no remediation to existing soil contamination. It would include thirty years of groundwater monitoring and implementation of a deed restriction. Because this alternative includes no remedial technologies, no changes in its configuration are required. Because consideration of this alternative is required for all areas of the site according to the National Contingency Plan (EPA 1990), it is potentially applicable to all soil operable units.

6.4.1.2 Alternative 2: Limited Action

This alternative would include institutional controls such as zoning and deed restrictions, access restrictions (i.e., fencing), and groundwater monitoring for a period of thirty years. All of these techniques are potentially applicable for limiting human exposure to the contaminants of concern in soil. Therefore, this alternative remains potentially applicable for operable units S-1, S-2, and S-3. However, this alternative may not be fully applicable to operable unit S-4 because some of the off-site contamination in this operable unit occurs on property which is not owned by UPRR and implementation of deed restrictions on property of this type may be difficult.

6.4.1.3 Alternative 3: Revegetation and Irrigation with Institutional Controls

This alternative would include dust control by revegetation and irrigation with deed and access restrictions (i.e., fencing) to address exposure pathways. Thirty-year monitoring of groundwater would also be included in this alternative to evaluate potential contaminant migration in soils to groundwater. This alternative would have to be reconfigured to address asbestos contamination in order to minimize disturbance of this material, and it would have to be reconfigured to address petroleum hydrocarbon contamination to minimize the potential for irrigation to mobilize this type of contamination and result in its migration to groundwater. Therefore, in its present configuration, this alternative is not applicable for S-1, S-2 and S-3. It would also be difficult to apply this alternative to S-4 because it would require the use of deed restrictions on land which is not owned by UPRR.

6.4.1.4 Alternative 4: Containment with Institutional Controls

This alternative would combine capping areas above RAOs with deed and access restrictions (i.e., fencing). This alternative would also include periodic inspection of the cap to evaluate the potential for any water to migrate through the cap to groundwater, and 30 years of groundwater monitoring. This alternative is appropriate for S-1 and S-3. It would eliminate the primary mobilizing mechanism (i.e., vertical infiltration of rainwater) and access to soil contamination, and would thus eliminate exposure pathways. This alternative is not applicable for S-2, the Central Fill Area, which contains TPH hot spots and potentially contains buried drums of unknown contents. This alternative is also not applicable for Operable Unit S-4. Implementation of deed and access restrictions on the off-site properties of S-4 which are not owned by UPRR may be difficult.

6.4.1.5 Alternative 5: Excavation/On-Site Treatment of Hot Spots with Capping

This alternative includes excavation and on-site treatment of hot spots of arsenic, lead and TPH (shown on Table 15 and Figures 38 through 45) with capping areas above RAOs and deed restrictions. This alternative would also include periodic inspection of the cap to evaluate the potential for any water to migrate through the cap to groundwater. It would eliminate the primary mobilizing mechanism (i.e., vertical infiltration of rainwater) and access to soil contamination, and would thus eliminate exposure pathways. Furthermore, since this alternative removes the highest levels of contaminants on-site and provides a cap, long-term groundwater monitoring is not required. On-site treatment might include: 1) soil washing for soils contaminated with metals, 2) bioremediation for TPH-contaminated soil, and 3) capping and dust control for areas of asbestos. After treatment and before capping, treated soils would be used to backfill the excavation.

Although this alternative proposes to remove and treat existing soil contamination, the likelihood of success is unknown for several reasons. First, this alternative proposes bioremediation to degrade organic contaminants. The feasibility of bioremediation for this purpose cannot be determined until treatability study testing has been conducted. However, work which has been conducted at other sites shows that bioremediation is difficult, time-consuming and costly for "heavy" hydrocarbons like the diesel fuel and motor oil which are believed to be the predominant organic contaminants at the UPRR site. These petroleum hydrocarbons contain higher-chain compounds (particularly 4- and 5-ring PAHs) which are relatively immobile, may be toxic, and may take decades to degrade (EPA, 1985). In the Central Fill

Area (S-2), soils may also contain chlorinated solvents which are difficult to degrade without the production of undesirable byproducts like vinyl chloride (EPA, 1985).

Second, this alternative proposes to use soil washing to remove metals from soil. Again, the feasibility of this technology cannot be fully determined until after treatability studies are completed. However, most work which has been done with this technology has been done for organic contaminants. At this time, other than large scale mining technologies, soil washing is unproven for use on inorganic contaminants and particularly on inorganic contaminants in silty clays similar to those at this site. In fact, recent experience with removing lead from soil at other UPRR sites indicates that maximum removal efficiencies may be no more than 20 percent. Soil washing systems which have been proposed for this purpose sometimes contain numerous solid-liquid and liquid-liquid separation steps. The more steps used, the higher the costs. Furthermore, soil washing systems frequently generate wastewater which must be discharged under permit and sludge which requires additional treatment or disposal (GRI, 1987).

In addition, the number of vendors in California which offer full-scale mobile soil washing units is very limited. In fact, there are only about five companies in North America which have or are in the process of developing this type of technology. These include:

- C.F. Systems (based in Massachusetts);
- RCC (based in Washington);
- ART International (based in New Jersey);
- Sanexan (based in Quebec, Canada); and
- Westinghouse Science and Technology (based in Pennsylvania).

Finally, the combination of metals and organic contaminants which exist together in site soils suggests that treatment using this alternative would involve a significant amount of material handling. Several rounds of soil washing would have to be conducted, followed by confirmatory sampling, followed by bioremediation and additional confirmatory sampling. Each additional step would significantly increase time and costs.

This alternative is applicable for S-1, S-3, and S-4. This alternative would probably not be applicable for operable unit S-2, the Central Fill Area, due to the potential difficulty of treating buried drums.

6.4.1.6 Alternative 6: Excavation/Off-Site Disposal of Hot Spots with Capping

This alternative includes excavation and off-site disposal of hot spots at an approved landfill facility, capping areas which have not been excavated and have soil above RAOs, and deed restrictions.

This alternative would also include periodic inspection of the cap to evaluate the potential for any water to migrate through the cap to groundwater. It would eliminate the primary mobilizing mechanism (i.e., vertical infiltration of rainwater) and access to soil contamination, and would thus eliminate exposure pathways. Furthermore, since this alternative removes the highest levels of contaminants on-site and provides a cap, long-term groundwater monitoring is not required. No treatment of contaminated soils would be conducted except to comply with "land ban" regulations, if necessary. This alternative would be generally applicable to all operable units.

6.4.1.7 <u>Alternative 7: Excavation/Off-Site Treatment/Disposal of Hot Spots with Capping</u>

This alternative would include excavation and off-site treatment of hot spots, capping areas which have been excavated and have soil above RAOs, and deed restrictions. This alternative would also include periodic inspection of the cap to evaluate the potential for any water to migrate through the cap to groundwater. It would eliminate the primary mobilizing mechanism (i.e., vertical infiltration of rainwater) and access to soil contamination, and would thus eliminate exposure pathways. Furthermore, since this alternative removes the highest levels of contaminants on-site and provides a cap, long-term groundwater monitoring is not required. TPH-contaminated soil would be treated using bioremediation. Soil contaminated with metals would be treated using soil washing.

Although this alternative proposes to remove and treat existing soil contamination, the likelihood of success is unknown for several reasons. First, this alternative proposes bioremediation to degrade organic contaminants. The feasibility of bioremediation for this purpose cannot be determined until treatability study testing has been conducted. However, work which has been conducted at other sites shows that bioremediation is more difficult, time-consuming and costly for "heavy" hydrocarbons like the diesel fuel and motor oil which is believed to be the predominant organic contaminants at the UPRR site. These petroleum hydrocarbons contain higher-chain compounds (particularly 4- and 5-ring PAHs) which are relatively immobile, may be toxic, and can take decades to degrade (EPA, 1985). In the Central Fill Area (S-2), soils may also contain chlorinated solvents which are difficult to degrade without the production of undesirable byproducts like vinyl chloride (EPA, 1985).

Second, this alternative proposes to use soil washing to remove metals from soil. Again, the feasibility of this technology cannot be fully determined until after treatability studies are completed. Most work which has been done with this technology has been done for organic contaminants. At this time, other than large scale mining technologies, soil washing is unproven for use on inorganic contaminants and particularly on inorganic contaminants in silty clays similar to those at this site. There are large-scale mining process facilities which may be able to treat the material. However, these facilities typically do not handle the low concentrations present in the soil, and therefore may not be efficient in removal of the low quantities. Furthermore, this would result in transportation, and possibly double-handling for two contaminants, which would significantly increase costs.

Finally, the combination of metals and organic contaminants which exist together in site soils suggests that treatment with this alternative would involve a significant amount of material handling. Several rounds of soil washing would have to be conducted, followed by confirmatory sampling, followed by bioremediation and additional confirmatory sampling. Each additional step would significantly increase time and costs.

This alternative would be applicable to operable units S-1, S-3, and S-4. This alternative may not be applicable to operable unit S-2, due to the potential difficulty of treating buried drums.

6.4.1.8 Alternative 8: In Situ Treatment of Soil Above RAOs with Institutional Controls

This alternative would include treating contaminated soils on the site. Treatment would include (1) fixation for soils contaminated with metals, and (2) bioremediation of soils contaminated with TPH. The applicability of this alternative to all operable units is poor because supplying the nutrients and oxygen which are necessary for in situ bioremediation would require the addition of liquid to soils. This in turn could mobilize TPH and metals, and groundwater contamination may result.

Furthermore, for S-1 and S-3, TPH and metals contamination overlap, and the ability of bioremediation in the presence of metals is unknown. For S-2, this alternative is not applicable unless all drums are removed prior to in situ treatment. The applicability of this alternative to operable unit S-4 is also poor, as these properties are not owned by UPRR.

6.4.1.9 Alternative 9: Excavation and On-Site Treatment of Soil Above RAOs

This alternative would combine excavation and on-site above-ground or in situ treatment to remediate all soil containing contaminants of interest at concentrations above RAOs. TPH contamination would be treated with bioremediation. Metals contamination would be treated with soil washing. Following treatment, the excavation would be backfilled with treated soil, graded, and compacted.

This alternative would not be applicable for S-2 without reconfiguration to allow for the excavation/off-site disposal required for buried drums. This alternative would be applicable for operable units S-1, S-3, and S-4.

6.4.1.10 Alternative 10: Excavation and Off-Site Disposal of Soil Above RAOs

This alternative would include complete excavation and disposal of soils containing concentrations of TPH, arsenic and/or lead, asbestos above the RAOs, and buried drums (and other debris, if necessary) in an off-site approved landfill facility. This would involve excavation, transportation, and disposal of a large volume of soil over a longer period of time than most other alternatives. The potential problems with treatment on soil contaminated with organic compounds and metals are discussed under alternatives 5 and 7. Added to the potential pitfalls would be a larger mobile plant required to treat a larger volume of soil, and a longer time would be required to treat the larger volume of soils. This would mean a longer period of time during which there would be potential impacts to the community; for example, increased noise and dust emissions. This alternative is applicable to all operable units.

6.4.2 Development of Groundwater Alternatives

Six groundwater remedial alternatives were originally presented in Section 3.2 of the Feasibility Study. These alternatives included no action; limited action with institutional controls; hydraulic containment; extract, pretreat, and discharge; extract, treat and reclaim; and in situ bioremediation. The six alternatives are described below and reevaluated based on the current understanding of the nature and extent of groundwater contamination.

6.4.2.1 Alternative 1: No Action

This alternative proposes to leave the groundwater in its present condition. It proposes neither remediation of groundwater contamination, nor groundwater monitoring. This alternative is potentially applicable to both operable units and is included primarily for comparison purposes, as required by the National Contingency Plan (EPA, 1990).

6.4.2.2 Alternative 2: Limited Action

The limited action alternative proposes to leave the groundwater in its present condition. As in Alternative 1, this alternative proposes no remediation, but includes monitoring groundwater for 30 years. In addition, this alternative provides for restricted access to contaminated groundwater by limiting drilling of groundwater wells through deed and permit restrictions. Since the plume is located in an area serviced by the city water supply (from treated surface water), public access to contaminated groundwater is expected to be minimal.

6.4.2.3 Alternative 3: Hydraulic Containment

This alternative proposes the use of hydraulic containment to prevent movement of the groundwater contamination plume. Extraction and injection wells would be constructed to provide the hydraulic barriers necessary for containing the groundwater contamination. Access to contaminated groundwater is regulated through deed and permit restrictions. Monitoring of groundwater for a period of 30 years is included.

This alternative is potentially applicable to both operable units; however, technically, it may be more difficult to implement for GW-1, which is larger than for GW-2. Suitable water for injection may be costly to obtain. Possible sources for injection water are treated groundwater or city-supplied treated surface water.

6.4.2.4 Alternative 4: Extract, Treat, and Discharge

This alternative proposes to extract impacted groundwater, treat, and directly discharge the treated groundwater to the City of Sacramento sewers which pipe water to a publicly-owned treatment works (POTW) operated by Sacramento County. Extraction wells would be placed for optimum containment and/or capture of the plume. Pretreatment, if needed, would reduce suspended solids by filtration and would adjust pH as necessary. Following pretreatment, full-scale ex-situ treatment with UV/oxidation, air stripping, Granular Activated Carbon (GAC), or any combination of the above, would be used to reduce contaminants to sewer discharge standards. Management of sludge residuals that may be produced from pretreatment will be achieved by off-site land-based disposal or thermal destruction. If GAC is the selected treatment option, the spent carbon would have to be transported off-site and regenerated.

This alternative restricts access to contaminated groundwater through deed and permit restrictions while the groundwater is being extracted. It also includes groundwater monitoring to assess contaminant removal.

This alternative is potentially applicable to both operable units, but its feasibility depends on allowable discharge limits (flow and concentration) of the extracted groundwater which will be defined in the POTW discharge permit. It is also dependent upon obtaining a special discharge permit from the Sacramento County Regional Sanitation District, and obtaining concurrence from the City of Sacramento Department of Public Works.

6.4.2.5 Alternative 5: Extract, Treat and Reclaim

This alternative proposes groundwater extraction, treatment, and discharge for reclamation. Extraction wells would be placed for optimum containment and/or capture of the plume. Pretreatment would reduce suspended solids by filtration and would adjust pH as necessary. Following pretreatment, full-scale ex-situ treatment with UV/oxidation, air stripping, Granular Activated Carbon (GAC), or any combination of the above, would be used to reduce contaminants to reclamation standards. Reclamation may include off-site use such as dust control, or irrigation. If GAC is the selected treatment option, the spent carbon would have to be transported off-site and regenerated. Management of sludge residuals that may be produced from pretreatment will be achieved by off-site land-based disposal or thermal destruction.

This alternative restricts access to contaminated groundwater through deed and permit restrictions while the groundwater is being extracted. It also includes monitoring to assess contaminant removal. It is potentially applicable to both operable units.

6.4.2.6 Alternative 6: In Situ Bioremediation

This alternative proposes to use in situ bioremediation in conjunction with pretreatment and full-scale, ex-situ treatment of groundwater. It includes the introduction of nutrients and/or bacteria into the groundwater to enhance the breakdown of the contaminants of interest. It proposes to use injection wells in conjunction with extraction wells to circulate the nutrients and create a hydraulic boundary to contain the plume.

This alternative restricts access to the aquifer through deed and permit restrictions while the groundwater is being treated. It includes monitoring to assess contaminant degradation. This alternative is potentially applicable to both operable units. However, treatability tests and a pilot study would need to be conducted to determine the feasibility of this alternative.

6.5 SCREENING OF ALTERNATIVES

6.5.1 Screening of Soil Alternatives

Nine of the ten alternatives listed above for soil were screened in Section 3.2 of the Feasibility Study using the criteria of cost, effectiveness, and implementability. However, given the new site characterization data and operable units, screening of soil alternatives has been re-evaluated. The ability of each alternative to satisfy each criteria is rated low, moderate or high. The results of this re-evaluation are described below and shown in Table 18.

6.5.1.1 Soil Alternative 1 - No Action

Operable Unit S-1

The effectiveness of this alternative relative to this operable unit is moderate. An existing fence limits direct contact but inhalation of contaminated dust may still occur. In addition, without remediation, asbestos may become friable and petroleum hydrocarbon contamination may migrate to groundwater.

The implementability of this alternative relative to this operable unit is moderate. This alternative includes no remedial technologies and is therefore not limited by the availability of equipment and/or experienced operators. However, since this alternative proposes no treatment of existing soil contamination, the ability to secure permits and approvals from regulatory agencies, and thus the administrative feasibility of this alternative may be low.

Since there are no remedial technologies associated with this alternative, costs are low and include only long-term groundwater monitoring. Therefore the cost effectiveness of this alternative is high.

Operable Unit S-2

The effectiveness of this alternative relative to this operable unit is low. Evidence indicates that S-2 may contain a potential source of groundwater contamination and without remediation, migration of contaminants may continue.

The implementability of this alternative relative to this operable unit is moderate. This alternative includes no remedial technologies and is therefore not limited by the availability of equipment and/or experienced operators. However, since this alternative proposes no treatment of existing soil contamination, the ability to secure permits and approvals from regulatory agencies, and thus the administrative feasibility of this alternative may be low.

Since there are no remedial technologies associated with this alternative, costs are low and include only long-term groundwater monitoring. Therefore the cost effectiveness of this alternative is high.

Operable Unit S-3

The effectiveness of this alternative relative to this operable unit is moderate. An existing fence limits direct contact but inhalation of contaminated dust may still occur.

The implementability of this alternative relative to this operable unit is moderate. This alternative includes no remedial technologies and is therefore not limited by the availability of equipment and/or experienced operators. However, since this alternative proposes no treatment of existing soil contamination, the ability to secure permits and approvals from regulatory agencies, and thus the administrative feasibility of this alternative may be low.

Since there are no remedial technologies associated with this alternative, costs are low and include only long-term groundwater monitoring. Therefore the cost effectiveness of this alternative is high.

Operable Unit S-4

The effectiveness of this alternative relative to this operable unit is low. There is no evidence that the concentrations of metals contamination in off-site soils which are present as the result of on-site activities represents a significant health risk (DTSC, 1991). However, this alternative provides limited mechanisms for control of direct contact with and/or inhalation of this material.

The implementability of this alternative relative to this operable unit is moderate. This alternative includes no remedial technologies and is therefore not limited by the availability of equipment and/or experienced operators. However, since this alternative proposes no treatment of existing soil contamination, the ability to secure permits and approvals from regulatory agencies, and thus the administrative feasibility of this alternative may be low.

Since there are no remedial technologies associated with this alternative, costs are low and include only long-term groundwater monitoring. Therefore the cost effectiveness of this alternative is high.

Rationale for Rejection/Selection

This alternative is required by the National Contingency Plan (EPA, 1990) in order to provide a baseline to compare other alternatives against. Therefore, it is selected for further consideration as a final candidate alternative for further analysis for all operable units at the UPRR Yard Sacramento site.

6.5.1.2 Soil Alternative 2 - Limited Action

Operable Unit S-1

The effectiveness of this alternative relative to this operable unit is moderate. An existing fence limits direct contact and deed restrictions may direct future land use so as to avoid site disturbance.

contamination, the ability to secure permits and approvals from regulatory agencies, and thus the administrative feasibility of this alternative may be low.

Since there are no remedial technologies associated with this alternative, costs are low and include only costs for deed restrictions and long-term groundwater monitoring. Therefore, the cost effectiveness of this alternative is high.

Operable Unit S-4

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy the screening criteria has not been evaluated.

Rationale for Rejection/Selection

This alternative is rejected for further consideration as a final candidate alternative for operable units S-1, S-2, and S-3. Considering the potential for generation of contaminated dust and potential migration of petroleum hydrocarbon contamination to groundwater, administrative approval of this alternative might be difficult to obtain. This alternative is not applicable to S-4.

6.5.1.3 Soil Alternative 3 - Revegetation and Irrigation with Institutional Controls

Operable Unit S-1

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy the screening criteria has not been evaluated.

Operable Unit S-2

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy the screening criteria has not been evaluated.

Operable Unit S-3

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy the screening criteria has not been evaluated.

Operable Unit S-4

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy the screening criteria has not been evaluated.

Rationale for Rejection/Selection

This alternative is not applicable to and is rejected for further consideration for all operable units. Although revegetation would limit exposure through direct contact and dust inhalation, the irrigation required would likely mobilize contaminants through soil to groundwater. With respect to operable unit S-4, an additional concern is the ability to implement deed restrictions on land which is not owned by UPRR.

6.5.1.4 Soil Alternative 4 - Containment with Institutional Controls

Operable Unit S-1

The effectiveness of this alternative relative to this operable unit is high because the capping of soils above RAOs would reduce the mobility of contaminants of concern and thus provide adequate protection of human health and the environment. It would eliminate the direct contact and inhalation exposure pathways.

The implementability of this alternative relative to this operable unit is high. The technical feasibility of capping is good since capping technologies are proven and well demonstrated, and since an abundance of capping materials and contractors are present in the Sacramento area. Furthermore, since this alternative proposes a proactive approach to limiting exposure to soil contamination, and eliminates the primary mobilizing mechanism for groundwater contamination (i.e. vertical infiltration of rainwater) it is likely that regulatory agency approval of this alternative can be obtained.

The cost effectiveness of this alternative relative to this operable unit is moderate. The areas requiring capping extend over most of this operable unit and complete capping is anticipated.

Operable Unit S-2

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy the screening criteria has not been evaluated.

Operable Unit S-3

The effectiveness of this alternative relative to this operable unit is high because the capping of soils above RAOs would reduce the mobility of these contaminants of concern and thus provide adequate protection of human health and the environment. It would eliminate the direct contact and inhalation exposure pathways.

The implementability of this alternative relative to this operable unit is high. The technical feasibility of capping is good since capping technologies are proven and well demonstrated, and since an abundance of capping materials and contractors are present in the Sacramento area. Furthermore, since this alternative proposes a proactive approach to limiting exposure to soil contamination, and eliminates the primary mobilizing mechanism for groundwater contamination (i.e. vertical infiltration of rainwater) it is likely that regulatory agency approval of this alternative can be obtained.

The cost effectiveness of this alternative relative to this operable unit is moderate. The areas requiring capping extend over most of this operable unit and complete capping is anticipated.

Operable Unit S-4

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy the screening criteria has not been evaluated.

Rationale for Rejection/Selection

This alternative is selected for further consideration as a final candidate for operable units S-1 and S-3 because it offers high effectiveness and high implementability at moderate cost. This alternative is not applicable to and is rejected for further consideration for S-2 and S-4. It is not applicable to S-2 because this area contains soil and materials which have been identified as potential groundwater contamination sources and which may migrate to groundwater. This alternative is not applicable to S-4 because deed notices restricting future land use would not likely be implementable on land which is not owned by UPRR.

6.5.1.5 Soil Alternative 5 - Excavation and On-Site Treatment of Hot Spots with Capping

Operable Unit S-1

The effectiveness of this alternative relative to this operable unit is moderate. Treatability studies for ex situ soil washing and bioremediation have not been completed and the potential reduction in toxicity, mobility and volume of soil contaminants afforded by this alternative is not yet known. However, these technologies, if well designed, should be able to produce at least a moderate reduction in mobility, volume and toxicity of metals in soils. Further, the capping of areas of soil above RAOs would provide a significant reduction in the toxicity, volume, and mobility of contaminants and provide adequate protection of public health and the environment.

The implementability of this alternative relative to this operable unit is moderate. The number of bioremediation vendors and available capacity in bioremediation treatment units is relatively high. The number of other remediation equipment vendors (particularly those which remove metals with soil washing) and the available capacity of the treatment units they operate is low. However, because it would reduce toxicity, mobility and volume of contaminants, the ability to secure regulatory agency approval of this alternative is expected to be good.

The cost effectiveness of this alternative is low. An estimate of the cost of the treatment technologies to be used as part of this alternative will not be known until after treatability studies are completed. However, such remedial measures are expensive because they involve not only excavation and handling, but treatment and sampling, as well.

Operable Unit S-2

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy screening criteria has not been evaluated.

Operable Unit S-3

The effectiveness of this alternative relative to this operable unit is moderate. Treatability studies for ex situ soil washing and bioremediation have not been completed and the potential reduction in toxicity, mobility and volume of soil contaminants afforded by this alternative is not yet known. However, these technologies, if well designed, should be able to produce at least a moderate reduction in mobility, volume and toxicity of metals in soils. Further, the capping of areas of soil above RAOs would provide a significant reduction in the toxicity, volume, and mobility of contaminants and provide adequate protection of public health and the environment.

The implementability of this alternative relative to this operable unit is moderate. The number of bioremediation vendors and available capacity in bioremediation treatment units is relatively high. The number of other remediation equipment vendors (particularly those which remove metals with soil washing) and the available capacity of the treatment units they operate is low. However, because it reduces toxicity, mobility, and volume of contaminants, the ability of this alternative to secure regulatory agency approval of this alternative is expected to be good.

The cost effectiveness of this alternative is low. An estimate of the cost of the treatment technologies to be used as part of this alternative will not be known until after treatability studies are completed. However, such remedial measures are expensive because they involve not only excavation and handling, but treatment and sampling as well.

Operable Unit S-4

The effectiveness of this alternative relative to this operable unit is moderate. There is no evidence that the concentrations of metals contamination in off-site soils present because of on-site activities, presents a significant health risk (DTSC, 1991). Until treatability studies for ex situ soil washing and bioremediation have been completed, the potential reduction in toxicity, mobility and volume of soil contaminants is unknown. However, if these treatment technologies are well designed, a moderate reduction should be achievable. Further, the capping of areas of soil above RAOs would provide a significant reduction in the toxicity, volume, and mobility of contaminants and provide adequate protection of public health and the environment.

The implementability of this alternative relative to S-4 is low. The number of bioremediation vendors and available capacity in bioremediation treatment units is high. The number of soil washing vendors and the available capacity of the treatment units they operate is low. This alternative reduces toxicity, mobility, and volume of contaminants. However, since this alternative proposes only partial removal of soil contamination which DTSC has identified as being of concern, the ability to secure administrative permits and approval could be poor.

The cost effectiveness of this alternative relative to this operable unit is low. If such measures were implemented, the anticipated low volumes to be treated would result in relatively high costs (i.e., treatment vendors cannot cheaply handle low volumes of soil).

Rationale for Rejection/Selection

This alternative is retained for further consideration for soil operable units S-1, and S-3 because of moderate effectiveness, and moderate implementability. It is not applicable to operable unit S-2 because of the difficulty of treating buried drums. This alternative is rejected for further consideration for S-4 because of the potentially poor acceptance by DTSC.

6.5.1.6 Alternative 6 - Excavation/Off-Site Disposal of Hot Spots with Capping

Operable Unit S-1

The effectiveness of this alternative relative to S-1 is high. Excavation and off-site disposal of hot spots and subsequent capping would reduce the volume and mobility of contaminants and provide adequate protection of human health and the environment.

The implementability of this alternative relative to this operable unit is high. Excavation, landfilling and capping technologies are proven and well demonstrated and equipment and trained operators are readily available. Since this alternative proposes a proactive approach to removing soil contamination, it is likely that permits and approvals from regulatory agencies can be obtained.

The cost effectiveness of this alternative relative to this operable unit is low. The volume of soil requiring removal would be high, and health and safety measures required during excavation would be costly. The volume of backfill required would be high and the area to be capped would be large. Thus, the cost of backfill and capping would also be costly. The volume of backfill required would be high and the area to be capped would be large. Thus the cost of backfill and capping would also be costly.

Operable Unit S-2

The effectiveness of this alternative relative to S-2 is high. Excavation, off-site disposal of hot spots and subsequent capping would reduce the volume and mobility of contaminants and provide adequate protection of human health and the environment.

The implementability of this alternative relative to this operable unit is high. Excavation, landfilling and capping technologies are proven and well demonstrated and equipment and trained operators are readily available. Since this alternative proposes a proactive approach to removing soil contamination (and buried drums), it is likely that permits and approvals from regulatory agencies can be obtained.

The cost effectiveness of this alternative relative to this operable unit is low. A large volume of soil in addition to drums, would require removal and the health and safety measures required during drum excavation would be costly. The volume of backfill required would be high and the area to be capped would be large. Thus the cost of backfill and capping would also be costly.

Operable Unit S-3

The effectiveness of this alternative relative to S-3 is high. Excavation and off-site disposal of hot spots and subsequent capping would reduce the volume and mobility of contaminants and provide adequate protection of human health and the environment.

The implementability of this alternative relative to this operable unit is high. Excavation, landfilling and capping technologies are proven and well demonstrated and equipment and trained operators are readily available. Since this alternative proposes a proactive approach to removing soil contamination, it is likely that permits and approvals from regulatory agencies can be obtained.

The cost effectiveness of this alternative relative to this operable unit is moderate. Although landfilling is costly, if excavation/off-site disposal of a limited volume of contaminated material is well managed, these costs can be minimized. The cost of capping is also expected to be moderate.

Operable Unit S-4

The effectiveness of this alternative relative to this operable unit is moderate. There is no evidence that the concentrations of metals contamination in off-site soils, present as the result of on-site activities, represents a significant health risk (DTSC, 1991). Nonetheless, this alternative reduces the mobility and volume of contamination. However, this alternative does not remove all contamination which DTSC indicates as being of concern, and it does not reduce the toxicity of contaminants.

The implementability of this alternative relative to this operable unit is moderate. Excavation, landfilling and capping technologies are proven and well demonstrated and there is an abundance of equipment and operators in the Sacramento area. However, since this alternative proposes only partial removal of soil contamination which DTSC has identified as being of concern, the ability to secure administrative permits and approval could be poor.

The cost effectiveness of this alternative relative to this operable unit is moderate. The cost of landfilling is high but the volume of soil to be excavated with this alternative and this operable unit is small.

Rationale for Rejection/Selection

This alternative is selected for further consideration for soil operable units S-1, S-2, and S-3, because of high effectiveness, high implementability, and moderate cost. This alternative is rejected for further consideration for S-4 because of the potentially poor acceptance by DTSC.

6.5.1.7 Alternative 7 - Excavation/Off-site Treatment/Disposal of Hot Spots with Capping

Operable Unit S-1

The effectiveness of this alternative relative to this operable unit is high. The complete removal of hot spots and capping of other areas of soil above RAOs would provide a significant reduction in the toxicity, volume and mobility of contaminants and provide adequate protection of public health and the environment.

The implementability of this alternative relative to S-1 is low. Off-site stationary treatment units are scarce. Furthermore, the handling of contaminated soil would be difficult. It would need to be transported from the site to the treatment facility, and finally to a landfill. The preparation and tracking of manifests and documentation would be time consuming and costly. Because of the scarcity of reliable off-site treatment units, the ability to secure permits and approvals from regulatory agencies is unknown.

The cost effectiveness of this alternative is low. Off-site treatment plus subsequent disposal involves significant transportation costs in addition to treatment/disposal costs. This would be added to the cost of capping the remainder of the contaminated soils/asbestos of S-1.

Operable Unit S-2

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy screening criteria has not been evaluated.

Operable Unit S-3

The effectiveness of this alternative relative to this operable unit is high. The complete removal of hot spots and capping of other areas of soil above RAOs would provide a significant reduction in the toxicity, volume and mobility of contaminants and provide adequate protection of public health and the environment.

The implementability of this alternative relative to S-3 is low. Off-site stationary treatment units are scarce. Furthermore, the handling of contaminated soil would be difficult. It would need to be transported from the site to the treatment facility, and finally to a landfill. The preparation and tracking of manifests and documentation would be time consuming and costly. Because of the scarcity of reliable off-site treatment units, the ability to secure permits and approvals from regulatory agencies is unknown.

The cost effectiveness of this alternative is low. Off-site treatment plus subsequent disposal involves significant transportation costs in addition to treatment/disposal costs. This would be added to the cost of capping the remainder of the contaminated soils of S-3.

Operable Unit S-4

The effectiveness of this alternative relative to this operable unit is moderate. There is no evidence that the concentrations of metals contamination in off-site soils, present as the result of on-site activities, represents a significant health risk (DTSC, 1991). Nevertheless, this alternative reduces the mobility and volume of contamination. However, this alternative does not remove all contamination which DTSC indicates as being of concern, and it does not reduce the toxicity of contaminants.

The implementability of this alternative relative to S-4 is low. Off-site stationary treatment units are scarce. Furthermore, the handling of contaminated soil would be difficult. It would need to be transported from the site to the treatment unit, and finally to a landfill. The preparation and tracking of manifests and documentation would be time consuming and costly. Because of the scarcity of reliable off-site treatment units, the ability to secure permits and approvals is unknown.

The cost effectiveness of this alternative relative to this operable unit is low. Off-site treatment and disposal would be expensive in comparison to the cost of other alternatives.

Rationale for Rejection/Selection

This alternative is rejected for operable units S-1, S-3, and S-4 because of low implementability and low cost effectiveness. This alternative is not applicable to operable unit S-2 because of the difficulty of treating buried drums.

6.5.1.8 Alternative 8 - In Situ Treatment of Soil Above RAOs with Institutional Controls

Operable Unit S-1

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy screening criteria has not been evaluated.

Operable Unit S-2

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy screening criteria has not been evaluated.

Operable Unit S-3

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy screening criteria has not been evaluated.

Operable Unit S-4

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy screening criteria has not been evaluated.

Rationale for Rejection/Selection

This alternative is not applicable to and is rejected for all operable units. The reasons for this action are that the mix of contaminants severely limit the effectiveness of this alternative and result in high cost (i.e. low cost effectiveness).

6.5.1.9 Alternative 9 - Excavation and On-Site Treatment of Soil Above RAOs

Operable Unit S-1

The effectiveness of this alternative relative to this operable unit is moderate. The excavation and on-site treatment of soil in S-1 above RAOs would provide increased protection of human health and the environment. However, until treatability studies are completed, the ability of treatment technologies to effectively reduce the toxicity, mobility and volume of contamination is unknown.

The implementability of this alternative relative to S-1 is low. Several remedial technologies would have to be used simultaneously, and the capacity of existing units and availability of trained operators for at least some technologies (i.e., soil washing) is low. Because of the unknown effectiveness of some treatment technologies, the ability of this alternative to receive permits and approvals from regulatory agencies is moderate.

The cost effectiveness of this alternative relative to S-1 is low. The excavation and on-site treatment of large volumes of soil requiring different remedial technologies would be expensive.

Operable Unit S-2

This alternative is not applicable to this operable unit. Therefore, its ability to satisfy screening criteria has not been evaluated.

Operable Unit S-3

The effectiveness of this alternative relative to this operable unit is moderate. The excavation and on-site treatment of soil in S-3 above RAOs would provide increased protection of human health and the environment. However, until treatability studies are completed, the ability of treatment technologies to effectively reduce the toxicity, mobility and volume of contamination is unknown.

The implementability of this alternative relative to S-3 is low. Several remedial technologies would have to be used simultaneously, and the capacity of existing units and availability of trained operators for at least some technologies (i.e., soil washing) is low. Because of the unknown effectiveness of some treatment technologies, the ability of this alternative to receive permits and approvals from regulatory agencies is moderate.

The cost effectiveness of this alternative relative to S-3 is low. The excavation and on-site treatment of soil requiring different remedial technologies would be expensive.

Operable Unit S-4

The effectiveness of this alternative relative to S-4 is high. There is no evidence that the concentrations of metals on off-site soils which are present because of on-site activities present a significant health risk (DTSC, 1991). However, if properly designed, this alternative could reduce volume, toxicity and mobility of contaminants on these properties and thus provide adequate protection of public health and the environment.

The implementability of this alternative relative to this operable unit is moderate. The capacity of existing units and the availability of trained operators for the treatment technologies which are proposed are limited. However, since this alternative proposes proactive removal of the soil contamination which is of concern to DTSC, its ability to secure administrative permits and approvals should be good.

The cost effectiveness of this alternative relative to this operable unit is low. Although the total volume of soil in this unit may not be significant, treatment of this volume would be relatively more costly than use of other alternatives.

Rationale for Rejection/Selection

This alternative is rejected for all operable units. The reasons are low cost effectiveness and low to moderate implementability.

6.5.1.10 Alternative 10 - Excavation and Off-site Disposal of Soil Above RAOs

Operable Unit S-1

The effectiveness of this alternative relative to this operable unit is high. By removing soils above RAOs, the volume, toxicity, and mobility of contaminants would be reduced. This would provide adequate protection of human health and the environment.

The implementability of this alternative relative to this operable unit is moderate. Excavation and landfilling technologies are proven and well demonstrated and equipment and skilled operators are readily available in the Sacramento area. However, the duration of such extensive removal operations may introduce an unacceptable degree of disturbance to the neighboring communities due to increased transportation traffic, noise, and dust. As a result, the ability of this alternative to secure agency permits and approvals may be limited.

Given the volume of contaminated soil included in S-1, the cost effectiveness of this alternative is low. Disposal of this volume of contaminated soil at an approved off-site landfill facility would be very expensive.

Operable Unit S-2

The effectiveness of this alternative relative to S-2 is high. Complete removal of the potential buried drums and contaminated soil would be effective in reducing the volume, toxicity, and mobility of contaminants and would provide adequate protection of human health and the environment.

The implementability of this alternative relative to this operable unit is moderate. Excavation and landfilling technologies are proven and well demonstrated and equipment and skilled operators are readily available. However, the duration of such extensive removal operations may introduce an unacceptable degree of disturbance to the neighboring communities due to increased traffic, noise, and dust. As a result, the ability of this alternative to secure agency permits and approvals and/or community acceptance may be limited.

Given the volume of contamination included in S-2, the cost effectiveness of this alternative is low. Disposal of this volume at an approved off-site landfill facility would be very expensive.

Operable Unit S-3

The effectiveness of this alternative relative to this operable unit is high. By removing soils above RAOs, the volume, toxicity, and mobility of contaminants would be reduced. This would provide adequate protection of human health and the environment.

The implementability of this alternative relative to this operable unit is moderate. Excavation and landfilling technologies are proven and well demonstrated and equipment and skilled operators are readily available in the Sacramento area. However, the duration of such extensive removal operations may introduce an unacceptable degree of disturbance to the neighboring communities due to increased transportation traffic, noise, and dust. As a result, the ability of this alternative to secure agency permits and approvals may be limited.

Given the volume of contaminated soil included in S-3, the cost effectiveness of this alternative is low. Disposal of this volume of contaminated soil at an approved off-site landfill facility would be expensive.

Operable Unit S-4

The effectiveness of this alternative relative to this operable unit is high. There is no evidence that the concentrations of metals contamination in off-site soils which is present as the result of on-site activities represents a significant health risk (DTSC, 1991). However, this alternative reduces the mobility and volume of contamination and thus provides adequate protection of human health and the environment.

The implementability of this alternative relative to this operable unit is high. Excavation, landfilling and capping technologies are proven and well demonstrated and there is an abundance of equipment and operators in the Sacramento area. Furthermore, since this alternative proposes proactive removal of the soil contamination which is of concern to DTSC, the ability to secure administrative permits and approval should be good.

The cost effectiveness of this alternative relative to this operable unit is moderate. The unit cost of landfilling is relatively high but because the volume of soil to be excavated with this alternative and this operable unit is small, the total cost is also relatively small.

Rationale for Rejection/Selection

This alternative is selected for further consideration as a final candidate alternative for operable units S-1, S-2, S-3, and S-4. The reasons are high effectiveness and moderate to high implementability.

6.5.2 Screening of Groundwater Alternatives

Screening of the six alternatives listed in Section 6.4 was conducted in the Feasibility Study. The validity of this screening was reviewed using new groundwater data to reevaluate effectiveness, implementability, and cost of the six alternatives. Only minor modifications have been made to update the earlier screening. These modifications were necessary in order to address revised operable unit volumes and the most current data. A summary of the screening of groundwater alternatives is provided in Table 19.

6.5.2.1 Groundwater Alternative 1 — No Action

Operable Unit 1 - GW-1

The effectiveness of this alternative for this operable unit is low. It does not protect the environment, would not meet the RAOs, and would not reduce the toxicity, mobility, or volume of contaminants in this operable unit.

The implementability of this alternative is low. Even though this alternative is technically feasible, it would not remove or treat groundwater contaminants, has poor administrative feasibility, and would probably not be acceptable to the state, local authorities, or the community.

There would be no costs associated with this alternative. Therefore, its cost effectiveness is high.

Operable Unit - GW-2

The effectiveness of this alternative for this operable unit is low. It does not protect the environment, would not meet the RAOs, and would not reduce the toxicity, mobility, or volume of contaminants in this operable unit.

The implementability of this alternative is low. Even though this alternative is technically feasible, it would not remove or treat groundwater contaminants, and therefore, would probably not be acceptable to the state, local authorities, or the community.

There would be no costs associated with this alternative. Therefore, its cost effectiveness is high.

Rationale for Rejection/Selection

This alternative is retained as a baseline alternative for both operable units to allow for a comparison of the relative reduction of risk afforded by other alternatives as required by the National Contingency Plan (EPA, 1990).

6.5.2.2 Groundwater Alternative 2 — Limited Action

Operable Unit GW-1

The effectiveness of this alternative for this operable unit is low. Deed and well permit restrictions would protect public health by reducing potential exposure, but this alternative would not protect the environment, or reduce toxicity, mobility, or volume of contaminants except through natural degradation and diffusion.

The implementability of this alternative is low. Even though this alternative is technically feasible, it has poor administrative feasibility, because leaving contaminants in place would probably not be acceptable to the state, local authorities, or the community.

There would be no costs associated with this alternative other than ongoing groundwater monitoring. Therefore, its cost effectiveness is high.

Operable Unit GW-2

The effectiveness of this alternative for this operable unit is moderate. Deed and well permit restrictions would help protect public health by reducing potential exposure. Furthermore, since contaminant levels in this operable unit are at or only slightly above RAOs, this alternative would effectively protect the environment, or reduce toxicity, mobility, or volume of contaminants through natural degradation and diffusion

The implementability of this alternative is moderate. This alternative is technically feasible, but its administrative feasibility may be poor because leaving contaminants in place on-site might not be acceptable to the state, local authorities, or the community. However, the levels of the contaminants are near the RAOs, which increases the likelihood of obtaining regulatory approval.

There would be no costs associated with this alternative, other than ongoing groundwater monitoring. Therefore, this alternative ranks high in cost effectiveness.

Rationale for Rejection/Selection

This alternative is rejected from further consideration for groundwater operable unit GW-1 since it is believed that this alternative will probably be not acceptable to the state, local authorities, or the community. This alternative is retained for further consideration for groundwater operable unit GW-2 based on its moderate ranking for effectiveness and implementability, and its high cost effectiveness.

6.5.2.3 Groundwater Alternative 3 — Hydraulic Containment

Operable Unit GW-1

The effectiveness of this alternative for this operable unit is moderate. Deed and well permit restrictions would aid in protecting human health by minimizing potential exposure. Containment would protect the environment by controlling the movement of the plume and allowing contaminant concentrations to diminish by natural degradation.

Implementability of this alternative for this operable unit is low. This alternative is technically feasible for this operable unit based on the current understanding of site hydrogeology. However, operation of an extraction and injection system may be difficult due to the size of this operable unit. Extensive monitoring of both water quality and water levels would be required to ensure containment of the plume. Landowner permission may be required for off-site placement of extraction and injection wells. Since this alternative leaves contaminants in place, it would probably not receive the approval of the state, local authorities or the community.

The cost effectiveness of this alternative is low. The costs associated with hydraulic containment and monitoring would be high due to the number of extraction, injection, and monitoring wells which would be required. In addition, the cost of obtaining a clean water source for injection may be expensive.

Operable Unit GW-2

The effectiveness of this alternative for this operable unit is moderate. Deed and well permit restrictions would aid in protecting human health by minimizing potential exposure. Containment would protect the environment by controlling the movement of the plume and allowing contaminant concentrations to diminish by natural degradation.

Implementability of this alternative for this operable unit is moderate. This alternative is technically feasible based on the current understanding of site hydrogeology and the limited areal extent of this operable unit. However, since this alternative leaves contaminants in place, it might not receive approval of the state, local authorities, or the community. However, the levels of contaminants are near RAOs, which increases the likelihood of obtaining regulatory approval.

The cost effectiveness of this alternative for this operable unit is low. The costs associated with this alternative would be high due to the number of wells required for injection, extraction and monitoring. The cost of obtaining clean water required for injection could also be high.

Rationale for Rejection/Selection

Due to low to moderate implementability and low cost effectiveness, this alternative is rejected for further analysis for both groundwater operable units.

6.5.2.4 Groundwater Alternative 4 — Extract, Treat and Discharge

Operable Unit GW-1

The effectiveness of this alternative for this operable unit is high. Extraction, treatment, and discharge of treated groundwater to the sewer would protect human health and the environment by reducing the toxicity, volume, and mobility of contaminated groundwater. Deed and well permit restrictions would minimize potential exposures to contaminated groundwater during remediation.

The implementability of this alternative for this operable unit is moderate. It is technically feasible using established technologies for treatment coupled with a system used to connect extraction wells and piping to the POTW. However, implementation of this alternative will require that agreements and a discharge permit be obtained from the appropriate agencies. A Memorandum of Understanding (MOU) will need to be entered into with the City of Sacramento regarding indemnification/liability for discharging into City sewer lines. An agreement will also need to be reached with, and a discharge permit obtained from, the County of Sacramento outlining allowable discharge contaminant levels and flow rates. Landowner permission for placement of off-site extraction wells on private property may also be required. The ability to obtain approval of these items is moderate.

The cost effectiveness of this alternative for this operable unit is low. The major cost for this alternative would be the capital and operating cost of the treatment system. The discharge to the POTW would require the payment of fees for permit application, connection, and usage. In addition, there would be costs for extraction well installation and piping to the discharge point (subsurface piping may need to be placed through city streets). Indemnification/liability costs to address the potential leakage of sewer lines may be high depending on the requirements of the City (MOU). Monitoring costs would also be part of the cost for implementing this alternative.

<u>Operable Unit GW-2</u>

The effectiveness of this alternative for this operable unit is high. Extraction, treatment, and discharge of treated groundwater to the sewer would protect human health and the environment by reducing the toxicity, volume, and mobility of contaminated groundwater. Deed and well permit restrictions would minimize potential exposures to contaminated groundwater during remediation.

The implementability of this alternative for this operable unit is moderate. It is technically feasible using established technologies for treatment coupled with a system used to connect extraction wells and piping to the POTW. Effluent concentrations of contaminants are expected to be low based on the low concentrations found in this operable unit. However, implementation of this alternative will require that agreements and a discharge permit be obtained from the appropriate agencies. A Memorandum of Understanding (MOU) will need to be entered into with the City of Sacramento regarding indemnification/liability for discharging into City sewer lines. An agreement will also need to be reached with and a discharge permit obtained from the County of Sacramento outlining allowable discharge contaminant levels and flow rates. The ability to obtain approval of these items is moderate.

The cost effectiveness of this alternative for this operable unit is low. The major cost for this alternative would be the capital and operating cost of the treatment system. The discharge to the POTW would require the payment of fees for permit application, connection, and usage. In addition, there would be costs for extraction well installation and piping (probably on-site) to a discharge point. Indemnification/liability costs to address the potential leakage of sewer lines may be high depending on the requirements of the City (MOU). Monitoring costs would also be part of the cost for implementing this alternative.

Rationale for Rejection/Selection

Based on its high ranking for effectiveness and moderate ranking for implementability ,this alternative is retained for further analysis for both operable units.

6.5.2.5 Groundwater Alternative 5 — Extract, Treat and Reclaim

Operable Unit GW-1

The effectiveness of this alternative for this operable unit is high. It would remove and treat contaminated groundwater from the aquifer, then use the treated water for a variety of purposes. This alternative would provide protection of human health and the environment and reduce toxicity, mobility, and volume of contaminants. Deed and well permit restrictions would minimize potential exposures to contaminated groundwater during remediation.

The implementability of this alternative for this operable unit is low. It is technically feasible using established technologies for treatment. However, use of reclaimed water for irrigation and dust control would require special permits and a water balance evaluation. A means of containing the treated water, such as a large water storage tank would be required, as well as a system to distribute the water. Periodic monitoring of the effluent from the treatment system would be necessary. Landowner permission for placement of off-site extraction wells on private property may also be required. The ability of this alternative to receive approval from regulatory agencies is unknown.

The cost effectiveness of this alternative for this operable unit is low. The major cost for this alternative would be the capital and operating cost of the treatment system and development of a storage and distribution system for reclaimed water. Other costs would include the cost of off-site installation of extraction wells, trenching and subsurface piping (possibly through city streets).

Operable Unit GW-2

The effectiveness of this alternative for this operable unit is high. It would remove and treat contaminated groundwater from the aquifer, then use the treated water for a variety of uses. This alternative would provide protection of human health and the environment and reduce toxicity, mobility, and volume of contaminants. Deed and well permit restrictions would minimize potential exposures to contaminated groundwater during remediation.

The implementability of this alternative for this operable unit is low. It is technically feasible using established technologies for treatment. However, use of reclaimed water for irrigation and dust control would require special permits and a water balance evaluation. A means of containing the treated water, such as a large water storage tank would be required, as well as a system to distribute the water. Periodic monitoring of the effluent from the treatment system would be necessary. The ability of this alternative to receive approval from regulatory agencies is unknown.

The cost effectiveness of this alternative for this operable unit is low. Major costs for this alternative would be the extraction well installation and capital and operating cost of the treatment system, as well as development of a storage and distribution system for reclaimed water. Relative to the cost of other alternatives, these costs are high.

Rationale for Rejection/Selection

Based on the low ranking for implementability and cost effectiveness, this alternative is rejected for both groundwater operable units.

6.5.2.6 Groundwater Alternative 6 — In Situ Bioremediation

Operable Unit GW-1

The effectiveness of this alternative for this operable unit is unknown. It could potentially provide reduction of groundwater contamination through biological activity. This alternative may provide protection of human health and the environment and reduce the toxicity, volume, and mobility of contaminants in groundwater. Deed and well permit restrictions would minimize potential exposures to contaminated groundwater during remediation.

The implementability of this alternative for this operable unit is low. In situ bioremediation is an innovative technology and its effectiveness would have to be demonstrated by a laboratory treatability test and pilot scale test if this alternative was selected for site remediation. Environmental impacts of this alternative would have to be further evaluated as to the effect of injecting nutrients (i.e., methane) and an oxygen source into the aquifer. Landowner permission for placement of off-site extraction and injection wells on private property may also be required. The ability of this alternative to receive approval from regulatory agencies is unknown.

If treatability studies show the technology to be effective at this site given the site specific chemical and hydrogeologic conditions and contaminants, the cost effectiveness of this alternative for this operable unit could be high. The major costs for this alternative would be the capital and operating costs of the treatment system. The laboratory and pilot scale treatability studies required prior to remedial design of this alternative would also represent a significant cost.

Operable Unit GW-2

The effectiveness of this alternative for this operable unit is unknown. It could potentially provide reduction of groundwater contamination through biological activity. This alternative may provide protection of human health and the environment and reduce the toxicity, volume, and mobility of contaminants in groundwater. Deed and well permit restrictions would minimize potential exposures to contaminated groundwater during remediation.

The implementability of this alternative for this operable unit is low. In situ bioremediation is an innovative technology and its effectiveness would have to be demonstrated by a laboratory treatability test and pilot scale test if this alternative was selected for site remediation. Environmental impacts of this alternative would have to be further evaluated as to the effect of injecting nutrients (i.e., methane) and an oxygen source into the aquifer. The ability of this alternative to receive approval from regulatory agencies is unknown.

If treatability studies show the technology to be effective at this site given the site-specific chemical and hydrogeologic conditions and contaminants, the cost effectiveness of this alternative for this operable unit could be high. The major costs for this alternative would be the capital and operating costs of the treatment system. The laboratory and pilot scale treatability studies required prior to remedial design of this alternative would also represent a significant cost.

Rationale for Rejection/Selection

This alternative is rejected for further analysis for both operable units based on its unknown effectiveness and low implementability.

6.6 DETAILED ANALYSIS OF ALTERNATIVES

This section presents detailed analysis of the previously screened soil and groundwater alternatives.

Each of these alternatives is evaluated in the following sections against nine criteria, namely:

- Short-term effectiveness;
- Long-term effectiveness;
- Reduction of toxicity, mobility, and/or volume;
- Implementability;
- Cost;
- Compliance with ARARs;
- Overall protection of human health and the environment;
- State acceptance; and
- Community acceptance.

The ability of each alternative to satisfy each criteria is rated poor, fair or good.

6.6.1 Soil Alternatives

Of the ten alternatives which were screened for S-1, S-2, S-3 and S-4 in the previous section, five alternatives were retained. These include:

Alternative 1 - No Action for S-1, S-2, S-3 and S-4;
Alternative 4 - Containment With Institutional Controls for S-1, S-3 (Figure 46);
Alternative 5 - Excavation and On-Site Treatment of Hot Spots with Capping for S-1, S-3 (Figure 47);
Alternative 6 - Excavation and Off-Site Disposal of Hot Spots with Capping for S-1, S-2, S-3 (Figure 48); and
Alternative 10 - Excavation and Off-Site Disposal of Soil Above RAOs (S-1, S-2, S-3, S-4) (Figure 49).

Since at least one of these alternatives was not addressed in the RI/FS Report and since none of these alternatives have been applied to the new operable units for soil at the site, it was necessary to conduct a new detailed analysis of these alternatives using the nine screening criteria listed above. The results of this analysis are described below.

6.6.1.1 Alternative 1 - No Action (S-1)

This section evaluates this alternative for operable unit S-1. This alternative includes the following elements:

- No remediation of contamination;
- Deed restrictions;
- Access restrictions;
- Long-term (i.e., 30 years) groundwater monitoring using a total of 40 monitoring wells; and
- Preparation of an annual groundwater monitoring report.

Short-Term Effectiveness

The short-term effectiveness of this alternative for this operable unit is fair. Although direct contact with contaminated soils is prohibited because of an existing fence around the perimeter of the site, contaminated dust from the site and the vertical migration of contaminants to groundwater represent a potential health risk to the public and potential environmental impacts. There might also be risks to site workers who could potentially come in contact with soil contaminants during groundwater monitoring activities.

Long-Term Effectiveness

The long-term effectiveness of this alternative for this operable unit is poor. It would not satisfy RAOs, and would not provide adequate protection of workers, the community or the environment.

Reduction of Toxicity, Mobility and/or Volume

This alternative would not result in a reduction of the toxicity, mobility or volume of contaminants or contaminated soil at the site. Therefore, its ability to satisfy this criteria would be poor.

Implementability

The implementability of this alternative is fair. This alternative proposes no treatment of contamination and groundwater monitoring uses well demonstrated and proven technologies. Therefore, the technical feasibility of this alternative is good. However, the administrative feasibility of this alternative is likely to be poor. This is a result of the preference of regulatory agencies to favor permanent and/or innovative technologies which include treatment of contamination.

The time required to implement this alternative is less than one year because of limited permitting requirements and limited light construction activities (Table 20). It would take approximately four weeks to prepare a groundwater monitoring work plan. It is estimated that it would take approximately eight weeks to obtain the necessary deed restrictions. A fence already exists around the inactive portion of the site. Modification and/or repair of the existing fence would take approximately eight weeks at eight hours per day, five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $803,000 (Table 21 and Appendix G). This estimated cost includes both capital and operation and maintenance cost. Capital costs are estimated to be approximately $105,000. These costs include the cost to develop a deed restriction and implement access restrictions (i.e., repair the existing fence and/or build a new fence around the site). Operation and maintenance costs are estimated to be approximately $1,170,000. These costs include groundwater monitoring using existing wells for a period of 30 years. They assume that monitoring will be conducted on a quarterly basis for the first two years, semi-annually for the next three years, and annually for the remainder of the 30-year period. Estimates of operation and maintenance costs were made using a 5 percent rate of return.

Compliance with ARARs

The ARARs for this alternative include 40 CFR, Parts 50, 61, 141, 142, 261, 264 and 265. They also include 29 CFR 1910, Title 17, 19, 22 and 23 of the California Code of Regulations, and Chapters 6.5, 6.6 and 7.0 of the California Health and Safety Code. Of these ARARs, this alternative would probably not comply with 40 CFR Parts 50, 61, 264, 265, and Title 17, 22 and 23 of the California Code of Regulations. Therefore, the ability of this alternative to satisfy these this is poor.

Overall Protection of Human Health and the Environment

The overall protection of human health and the environment provided by this alternative would be poor. It would not reduce the risk of inhalation of contaminated dust and would not reduce the potential for migration of soil contaminants to groundwater. It would not satisfy RAOs.

State Acceptance

State acceptance of this alternative is unknown but is likely to be poor. More information about this issue will become available following the State's review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of this alternative is unknown but is likely to be poor. To date, no formal comments on this alternative have been received from the community. This information will not be available following the State's review and comment on this Addendum RI/FS and the Draft RAP.

6.6.1.2 Alternative 1 - No Action (S-2)

This section evaluates this alternative for operable unit S-2. This alternative includes the following elements:

- No remediation of contamination;
- Deed restrictions;
- Access restrictions;
- Long-term (i.e., 30 years) groundwater monitoring using a total of 40 monitoring wells; and
- Preparation of an annual groundwater monitoring report.

Short-Term Effectiveness

The short-term effectiveness of this alternative for this operable unit is fair. Although direct contact with contaminated soils is prohibited because of an existing fence around the perimeter of the site, contaminated dust from the site and the vertical migration of contaminants to groundwater represent a potential health risk to the public and potential environmental impacts. There might also be risks to site workers who could potentially come in contact with soil contaminants during groundwater monitoring activities.

Long-Term Effectiveness

The long-term effectiveness of this alternative for this operable unit is poor. It would not satisfy RAOs, and would not provide adequate protection of workers, the community or the environment.

Reduction of Toxicity, Mobility and/or Volume

This alternative would not result in a reduction of the toxicity, mobility or volume of contaminants or contaminated soil at the site. Therefore, its ability to satisfy this criteria would be poor.

Implementability

The implementability of this alternative is fair. This alternative proposes no treatment of contamination and groundwater monitoring uses well demonstrated and proven technologies. Therefore, the technical feasibility of this alternative is good. However, the administrative feasibility of this alternative is likely to be poor. This is due to the fact that regulatory agencies seem to favor permanent and/or innovative technologies which include treatment of contamination.

The time required to implement this alternative is less than one year because of limited permitting requirements and limited light construction activities (Table 20). It would take approximately four weeks to prepare a groundwater monitoring work plan. It is estimated that it would take approximately eight weeks to obtain the necessary deed restrictions. A fence already exists around the inactive portion of the site. Modification and/or repair of the existing fence would take approximately three weeks at eight hours per day, five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $731,000 (Table 21 and Appendix G). This estimated cost includes both capital and operation and maintenance cost. Capital costs are estimated to be approximately $30,000. These costs include the cost to develop a deed restriction and implement access restrictions (i.e., repair the existing fence and/or build a new fence around the operable unit). Operation and maintenance costs are estimated to be approximately $1,170,000. These costs include groundwater monitoring using existing wells for a period of 30 years. They assume that monitoring will be conducted on a quarterly basis for the first two years, semi-annually for the next three years, and annually for the remainder of the 30-year period. Estimates of operation and maintenance costs were made using a 5 percent rate of return.

Compliance with ARARs

The ARARs for this alternative include 40 CFR, Parts 50, 61, 141, 142, 261, 264 and 265. They also include 29 CFR 1910, Title 17, 19, 22 and 23 of the California Code of Regulations, and Chapters 6.5, 6.6 and 7.0 of the California Health and Safety Code. Of these ARARs, this alternative would probably not comply with 40 CFR Parts 50, 61, 264, 265, and Title 17, 22 and 23 of the California Code of Regulations. Therefore, the ability of this alternative to satisfy this criteria is poor.

Overall Protection of Human Health and the Environment

The overall protection of human health and the environment provided by this alternative would be poor. It would not reduce the risk of inhalation of contaminated dust and would not reduce the potential for migration of soil contaminants to groundwater. It would not satisfy RAOs.

State Acceptance

State acceptance of this alternative is unknown, but is likely to be poor. More information about this issue will become available following the State's review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of this alternative is unknown but is likely to be poor. To date, no formal comments on this alternative have been received from the community. This information will be available following the State's review and comment on this Addendum RI/FS and the Draft RAP.

6.6.1.3 Alternative 1 - No Action (S-3)

This section evaluates this alternative for operable unit S-3. This alternative includes the following elements:

- No remediation of contamination;
- Deed restrictions;
- Access restrictions;
- Long-term (i.e., 30 years) groundwater monitoring using a total of 40 monitoring wells; and
- Preparation of an annual groundwater monitoring report.

Short-Term Effectiveness

The short-term effectiveness of this alternative for this operable unit is fair. Although direct contact with contaminated soils is prohibited because of an existing fence around the perimeter of the site, contaminated dust from the site and the vertical migration of contaminants to groundwater represent a potential health risk to the public and potential environmental impacts. There might also be risks to site workers who could potentially come in contact with soil contaminants during groundwater monitoring activities.

Long-Term Effectiveness

The long-term effectiveness of this alternative for this operable unit is poor. It would not satisfy RAOs, and would not provide adequate protection of workers, the community or the environment.

Reduction of Toxicity, Mobility and/or Volume

This alternative would not result in a reduction of the toxicity, mobility or volume of contaminants or contaminated soil at the site. Therefore, its ability to satisfy this criteria would be poor.

Implementability

The implementability of this alternative is fair. This alternative proposes no treatment of contamination and groundwater monitoring uses well demonstrated and proven technologies. Therefore, the technical feasibility of this alternative is good. However, the administrative feasibility of this alternative is likely to be poor. This is due to the fact that regulatory agencies seem to favor permanent and/or innovative technologies which include treatment of contamination.

The time required to implement this alternative less than one year because of limited permitting requirements and limited light construction activities (Table 20). It would take approximately four weeks to prepare a groundwater monitoring workplan. It is estimated that it would take approximately eight weeks to obtain the necessary deed restrictions. A fence already exists around the inactive portion of the site. Modification and/or repair of the existing fence is expected to take approximately four weeks at eight hours per day, five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $753,000 (Table 21 and Appendix G). This estimated cost includes both capital and operation and maintenance cost. Capital costs are estimated to be approximately $53,000. These costs include the cost to develop a deed restriction and implement access restrictions (i.e., repair the existing fence and/or build a new fence around the operable unit). Operation and maintenance costs are estimated to be approximately $1,170,000. These costs include groundwater monitoring using existing wells for a period of 30 years. They assume that monitoring will be conducted on a quarterly basis for the first two years, semi-annually for the next three years, and annually for the remainder of this 30-year period. Estimates of operation and maintenance costs were made using a 5 percent rate of return.

Compliance with ARARs

The ARARs for this alternative include 40 CFR, Parts 50, 61, 141, 142, 261, 264 and 265. They also include 29 CFR 1910, Title 17, 19, 22 and 23 of the California Code of Regulations, and Chapters 6.5, 6.6 and 7.0 of the California Health and Safety Code. Of these ARARs, this alternative would probably not comply with 40 CFR Parts 50, 61, 264, 265, and Title 17, 22 and 23 of the California Code of Regulations. Therefore, the ability of this alternative to satisfy this criteria is poor.

Overall Protection of Human Health and the Environment

The overall protection of human health and the environment provided by this alternative would be poor. It would not reduce the risk of inhalation of contaminated dust and would not reduce the potential for migration of soil contaminants to groundwater. It would not satisfy RAOs.

State Acceptance

State acceptance of this alternative is unknown, but is likely to be poor. More information about this issue will become available following the State's review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of this alternative is unknown but is likely to be poor. To date, no formal comments on this alternative have been received from the community. This information will be available following the State's review and comment on this Addendum RI/FS and the Draft RAP.

6.6.1.4 Alternative 1 - No Action (S-4)

This section evaluates this alternative for operable unit S-4. This alternative includes the following elements:

- No remediation of contamination;
- Deed restrictions;
- Access restrictions;
- Long-term (i.e., 30 years) groundwater monitoring using a total of 40 monitoring wells; and
- Preparation of an annual groundwater monitoring report.

Short-Term Effectiveness

The short-term effectiveness of this alternative is poor. The concentrations of contaminants of concern in this operable unit do not represent a significant health risk to the public (DTSC, 1991). However, these concentrations are elevated relative to background concentrations, and access controls (i.e., fencing) in place to prevent direct contact with contaminants are inadequate. The close proximity of contaminants in this operable unit to nearby residents is also of concern because of the possible inhalation of contaminated dust. This alternative would not address either direct contact with or inhalation of off-site contaminants for the public or for site workers who might conduct groundwater monitoring in these areas. It would also not address the potential migration of contaminants to groundwater, although the potential for migration of contaminants to groundwater in off-site areas is likely to be minimal.

Long-Term Effectiveness

The long-term effectiveness of this alternative is poor. It would not satisfy RAOs, and would not provide adequate protection of the community, workers, or the environment.

Reduction of Toxicity, Mobility and/or Volume

This alternative would not result in a reduction of the toxicity, mobility or volume of contaminants or contaminated soil at the site. Therefore, its ability to satisfy this criteria would be poor.

Implementability

The implementability of this alternative is poor. Since it does not propose the use of any treatment technologies and since groundwater monitoring uses well demonstrated and proven technologies, the technical feasibility of this alternative is good. However, the administrative feasibility of this technology is likely to be poor. Not only does it not include treatment of contaminants using a permanent solution, which is favored by regulatory agencies, it fails to address the potential health risk to the public from off-site contaminants. As stated above, this risk is not significant, and is, in fact, less than health risks to the public posed by on-site contaminants. Nonetheless, use of this alternative would not be acceptable to regulatory agencies because of a lack of existing access controls for this operable unit.

The time required to implement this alternative is short because of limited permitting requirements and light construction activities (Table 20). It would require four weeks to prepare a work plan for DTSC review and approval. It is estimated that it would take approximately two weeks to obtain the necessary construction permits and eight weeks for deed restrictions. Construction of the fence is expected to require approximately two weeks, assuming eight hours per day, five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $709,000 (Table 21 and Appendix G). This estimated cost includes both capital and operation and maintenance cost. Capital costs are estimated to be approximately $6,000. These costs include the cost to develop a deed restriction and implement access restrictions (i.e., repair the existing fence and/or build a new fence around the operable unit). Operation and maintenance costs are estimated to be approximately $1,170,000. These costs include groundwater monitoring using existing wells for a period of 30 years. They assume that monitoring will be conducted on a quarterly basis for the first two years, semi-annually for the next three years, and annually for the remainder of this 30-year period. Estimates of operation and maintenance costs were made using a 5 percent rate of return.

Compliance with ARARs

The ARARs for this alternative include 40 CFR, Parts 50, 61, 141, 142, 261, 264 and 265. They also include 29 CFR 1910, Title 17, 19, 22 and 23 of the California Code of Regulations, and Chapters 6.5, 6.6 and 7.0 of the California Health and Safety Code. Of these ARARs, this alternative would probably not comply with 40 CFR Parts 50, 61, 264, 265, and Title 17, 22 and 23 of the California Code of Regulations. Therefore, the ability of this alternative to satisfy these criteria is poor.

Overall Protection of Human Health and the Environment

The overall protection of human health and the environment provided by this alternative would be poor. It would not reduce the risk of direct contact with or inhalation of contamination and would not reduce the potential for migration of soil contaminants to groundwater. It would not satisfy RAOs.

State Acceptance

State acceptance of this alternative is unknown, but is likely to be poor. More information about this issue will become available following the State's review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

Although no formal comments on this alternative, as configured, have been received to date from the public, community acceptance of this alternative is likely to be low. At a community meeting held on August 13, 1991 by the Sierra-Curtis Neighborhood Association, several residents voiced concerns about the potential presence of soil contamination in their yards, the potential for contaminant migration from the adjacent UPRR site to their residences, and the potential health effects associated with exposure to contamination from the site.

6.6.1.5 Alternative 4 - Containment With Institutional Controls (S-1)

This section evaluates this alternative for operable unit S-1. This alternative includes the following elements:

- Grubbing (removal) of existing vegetation;
- Grading and removal of construction debris;
- Installation of an asphalt cap;
- Dust control measures;
- Air monitoring during cap installation;
- Installation of drainage controls;
- Repair and/or replacement of perimeter fence;
- Implementation of deed restriction;
- Annual inspection/maintenance of cap;
- Groundwater monitoring using a total of 40 monitoring wells for 30 years; and
- Preparation of annual cap inspection, maintenance and monitoring report.

Short-Term Effectiveness

This alternative would provide fair short-term effectiveness. Grubbing, grading and asphalt paving activities would result in a temporary increase in the amount of fugitive dust at the site. However, these potential impacts to the community and to workers on-site would be mitigated through implementation of several dust control measures. These include water spraying and/or use of vapor suppressant foam, ambient air monitoring, and the use of plans to shut down operations whenever the speed of wind exceeds a predetermined value, or the direction of the wind is determined to be unfavorable.

In addition to dust generation, this alternative has the potential to create several short-term environmental impacts. These include noise and traffic congestion in the vicinity of the site. Both impacts will be mitigated by restricting work at the site to those hours of the week when residents are most likely to be away from home. Traffic impacts may be further minimized by limiting the number of personal vehicles allowed at the site at any one time and keeping the daily transport of construction equipment to and from the site to a minimum.

Long-Term Effectiveness

This alternative would provide good long-term effectiveness. It would eliminate the direct contact and inhalation exposure pathways for this operable unit and would eliminate the primary mobilizing mechanism (i.e., vertical infiltration of rainwater) for soil contaminants migrating to groundwater. It would satisfy RAOs developed for soil and would not create and/or leave residuals on-site.

Reduction of Toxicity, Mobility and/or Volume

This alternative would eliminate the primary mobilizing mechanism (i.e., vertical infiltration of rainwater) and thus significantly reduce the mobility of soil contaminants. If it is assumed that surface soils at the site have permeability of 1×10^{-6} (Dames & Moore, 1991f), and if the permeability of an asphalt cap is 1×10^{-7} then this would be at least a 10-fold decrease in permeability. This alternative would not reduce the toxicity or volume of contaminants. Therefore, its ability to satisfy this criteria is fair.

Implementability

The implementability of this alternative when applied to this operable unit would be good. The technologies which it includes are proven and well demonstrated and there is a sufficient supply of required equipment and contractors with capping experience in the Sacramento area. Thus the technical feasibility of this alternative is good. Because this alternative proposes to eliminate public exposure to soil contaminants, reduce migration to groundwater, and because it includes long-term groundwater monitoring and deed restrictions, it is likely that this alternative would receive agency approval. Thus, the administrative feasibility of this alternative is also good.

The time required to implement this alternative is expected to be approximately 10 months (Table 20). The engineering design of the cap will take approximately three months. The permitting process should be completed by the end of that period. Construction of the cap is expected to take approximately 7 months, assuming an eight-hour work day, five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $4,748,000 (Table 21 and Appendix G). This includes both capital and operation and maintenance expenditures. Capital costs are estimated to be approximately $3,563,000. They include the cost for grubbing, grading, dust suppression, air monitoring, capping, fencing repair and/or replacement, and installation of drainage systems. Operation and maintenance costs are estimated to be approximately

$2,483,000. These include the costs for long-term groundwater monitoring for 30 years using existing wells, annual inspection and maintenance of the cap, and preparation of an annual monitoring, inspection and maintenance report. This cost assumes a 5-percent rate of return.

Compliance with ARARs

The ARARs for this alternative include CEQA; 40 CFR Parts 50, 116, 261, 264, 265, 267, 268; 29 CFR Part 1910; Titles 19 and 22 of the California Code of Regulations; Articles 4.5, 5.0, 7.7 and 9.5 of the California Health and Safety Code; and the Toxic Substances Control Act. This alternative would comply with all these ARARs. Therefore, the ability of this alternative to satisfy this criteria is good.

Overall Protection of Human Health and the Environment

This alternative will provide good protection of human health and the environment. It will eliminate direct contact and inhalation exposure pathways and will significantly reduce the potential for migration of contaminants to groundwater. Although implementation of this alternative will result in a temporary increase in dust, noise and traffic, these impacts will be of short duration and can be mitigated through proper design.

State Acceptance

State acceptance of this alternative is currently unknown. However, since this alternative provides protection of human health and the environment with a proven technology, state acceptance is likely. Additional information regarding this issue will be available following State review and comment on this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of this alternative is unknown. There have been no formal comments received from the public on this alternative to date. Additional information regarding this issue will be available following review and comment on this Addendum RI/FS and the Draft RAP.

6.6.1.6 Alternative 4 - Containment With Institutional Controls (S-3)

This section evaluates this alternative for operable unit S-3. This alternative includes the following elements:

- Grubbing (removal) of existing vegetation;
- Grading and removal of construction debris;
- Installation of an asphalt cap;
- Dust control measures;
- Air monitoring during cap installation;
- Installation of drainage controls;
- Repair and/or replacement of perimeter fence;
- Implementation of deed restriction;
- Annual inspection/maintenance of cap;
- Groundwater monitoring using a total of 40 monitoring wells for 30 years; and
- Preparation of annual cap inspection, maintenance and monitoring report.

Short-Term Effectiveness

This alternative would provide fair short-term effectiveness. Grubbing, grading and asphalt paving activities would result in a temporary increase in the amount of fugitive dust at the site. However, these potential impacts to the community and to workers on-site would be mitigated through implementation of several dust control measures. These include water spraying and/or use of vapor suppressant foam, ambient air monitoring, and the use of plans to shut down operations whenever the speed of wind exceeds a predetermined value, or the direction of the wind is determined to be unfavorable.

In addition to dust generation, this alternative has the potential to create several short-term environmental impacts. These include noise and traffic congestion in the vicinity of the site. Both impacts will be mitigated by restricting work at the site to those hours of the week when residents are most likely to be away from home. Traffic impacts may be further minimized by limiting the number of personal vehicles allowed at the site at any one time and keeping the daily transport of construction equipment to and from the site to a minimum.

Long-Term Effectiveness

This alternative would provide good long-term effectiveness. It would eliminate the direct contact and inhalation exposure pathways for this operable unit and would eliminate the primary mobilizing mechanism (i.e., vertical infiltration of rainwater) for soil contaminants migrating to groundwater. It would satisfy RAOs developed for soil and would not create and/or leave residuals on-site.

Reduction of Toxicity, Mobility and/or Volume

This alternative would eliminate the primary mobilizing mechanism (i.e., vertical infiltration of rainwater) and thus significantly reduce the mobility of soil contaminants. If it is assumed that surface soils at the site have permeability of 1×10^{-6} (Dames & Moore, 1991), and if the permeability of an asphalt cap is 1×10^{-7} then this would be at least a 10-fold decrease in permeability. This alternative would not reduce the toxicity or volume of contaminants. Therefore, its ability to satisfy this criteria is fair.

Implementability

The implementability of this alternative when applied to this operable unit would be good. The technologies which it includes are proven and well demonstrated and there is a sufficient supply of required equipment and contractors with capping experience in the Sacramento area. Thus the technical feasibility of this alternative is good. Because this alternative proposes to eliminate public exposure to soil contaminants, reduce migration to groundwater, and because it includes long-term groundwater monitoring and deed restrictions, it is likely that this alternative would receive agency approval. Thus, the administrative feasibility of this alternative is also good.

The time required to implement this alternative is expected to be approximately 6 months (Table 20). The engineering design of the cap will take approximately three months. The permitting process should be completed by the end of that period. Construction of the cap is expected to take approximately 3 months, assuming an eight-hour work day, five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $1,480,000 (Table 21 and Appendix G). This includes both capital and operation and maintenance expenditures. Capital costs are estimated to be approximately $659,000. They include the cost for grubbing, grading, dust suppression, air monitoring capping, fence repair and/or replacement, and installation of drainage systems. Operation and maintenance costs are estimated to be approximately $1,469,000. These include the costs for long-term groundwater monitoring for 30 years using existing wells, annual inspection and maintenance of the cap, and preparation of an annual monitoring, inspection and maintenance report. This cost assumes a five-percent rate of return.

Compliance with ARARs

The ARARs for this alternative include CEQA; 40 CFR Parts 50, 116, 261, 264, 265, 267, 268; 29 CFR Part 1910; Titles 19 and 22 of the California Code of Regulations; Articles 4.5, 5.0, 7.7 and 9.5 of the California Health and Safety Code; and the Toxic Substances Control Act. This alternative would comply with all these ARARs. Therefore, the ability of this alternative to satisfy this criteria is good.

Overall Protection of Human Health and the Environment

This alternative will provide good protection of human health and the environment. It will eliminate direct contact and inhalation exposure pathways and will significantly reduce the potential for migration of contaminants to groundwater. Although implementation of this alternative will result in a temporary increase in dust, noise and traffic, these impacts will be of short duration and can be mitigated through proper design.

State Acceptance

State acceptance of this alternative is currently unknown. However, since this alternative provides protection of human health and the environment with a proven technology, state acceptance is likely. Additional information regarding this issue will be available following State review and comment on this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of this alternative is unknown. There have been no formal comments received from the public on this alternative to date. Additional information regarding this issue will be available following review and comment on this Addendum RI/FS and the Draft RAP.

6.6.1.7 Alternative 5 - Excavation/On-Site Treatment of Hot Spots with Capping (S-1)

This section evaluates this alternative for operable unit S-1. This alternative includes the following elements:

- Grubbing (removal) of existing vegetation;
- Grading and removal of construction debris;
- Excavation of Hot Spots (Table 15 and Figures 42 through 45);
- Air Monitoring During Remediation;

- Dust Suppression During Remediation;
- On-Site Treatment of Excavated Soil Using Soil Washing for Metals;
- Backfill On-Site Excavation with Treated Soil;
- Installation of an asphalt cap over remaining soil above RAOs;
- Installation of drainage controls;
- Implementation of deed restriction;
- Annual inspection/maintenance of cap; and
- Preparation of annual cap inspection and maintenance report.

Short-Term Effectiveness

The short-term effectiveness of this alternative would be fair. It would result in a temporary increase in dust, noise and traffic congestion on, and in the vicinity of S-1. Dust generation may produce an increase in risk to the public but could be mitigated with dust suppression methods which include air monitoring, water spraying, and use of plans to cease activities during periods of high or unfavorable winds. Noise and traffic congestion are environmental impacts which can be mitigated by conducting excavation and backfilling operations during those hours of the week when most residents are away from home, limiting the number of personal vehicles brought to the site, use of an off-site staging area for transport vehicles and limiting the amount of equipment brought to or taken from the site on a daily basis.

Long-Term Effectiveness

The long-term effectiveness of this alternative would be good. By removing the highest concentrations of contaminants of concern, significant protection of public health and the environment could be achieved. This action will also eliminate the need for long-term groundwater monitoring.

Reduction of Toxicity, Mobility and Volume

This alternative would reduce the toxicity, mobility and volume of contaminants at the site. Therefore, its ability to satisfy this criteria would be good.

Implementability

The implementability of this alternative is fair. Excavation, backfilling, compaction and groundwater monitoring require the use of proven and well demonstrated technologies and there is an abundance of equipment suppliers and trained operators in the Sacramento area. This alternative proposes to significantly reduce potential risks by removing hot spots, to eliminate potential exposure to soil contaminants, minimize infiltration of rainwater, and implement deed restrictions.

Although this alternative proposes to remove and treat existing soil contamination, the likelihood of success is unknown. The feasibility of this technology cannot be fully determined until after treatability studies are completed. However, most work which has been done with this technology has been done for organic contaminants. At this time, other than large scale mining technologies, soil washing is unproven for use on inorganic contaminants, and particularly inorganics present in silty clays similar to this site. In fact, recent experience with removing lead from soil at other UPRR sites indicates that maximum removal efficiencies may be no more than 20 percent. Soil washing systems which have been proposed for this purpose sometimes contain numerous solid-liquid and liquid-liquid separation steps. The more steps used, the higher the costs. Furthermore, soil washing systems frequently generate wastewater which must be discharged under permit, and sludge which requires additional treatment or disposal (GRI, 1987).

In addition, the number of vendors in California which offer full-scale mobile soil washing units is very limited. In fact, there are only about five companies in the United States which have or are in the process of developing this type of technology. However, if treatability studies show that this technology can be successful, and if reliable vendors can be located, this alternative is likely to secure agency approval and have good administrative feasibility.

The time required to implement this alternative is expected to be approximately 18 months (Table 20). This assumes three months for design, two to six months for permitting, six months for excavation, and three months for treatment. This assumes an eight-hour work day five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $9,181,000 (Table 21 and Appendix G). This includes capital, operation, and maintenance costs. Capital costs are approximately $8,956,000. Capital costs include the cost for air monitoring, dust suppressing, asphalt capping, excavation, hauling, backfilling and compaction. Operation and Maintenance costs are approximately $1,313,000. Operation and maintenance costs include the cost to operate and maintain one or more soil washing units on-site for three months. No groundwater monitoring are included in the cost of this alternative.

Compliance with ARARs

The ARARs for this alternative include CEQA; SCAQMD Rules and Regulations; 40 CFR Section 257, 260, 265, and 268; CCR Title 17, 19, 22 and 23 of the California Code of Regulations; California Health and Safety Code; Clear Air Act; and the Clean Water Act. This alternative would comply with all these ARARs. Therefore, its ability to satisfy this criteria is good.

Overall Protection of Human Health and the Environment

This alternative will provide good protection of human health and the environment. It will eliminate direct contact and inhalation exposure pathways and will significantly reduce the potential for migration of contaminants to groundwater. Although implementation of this alternative will result in a temporary increase in dust, noise and traffic, these impacts will be of short duration and can be mitigated through proper design.

State Acceptance

State acceptance of this alternative is currently unknown. However, if this alternative proves to be technically feasible, State acceptance is likely. Additional information regarding this issue will be available following State review and comment on this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of this alternative is unknown. There have been no formal comments received from the public on this alternative to date. Additional information regarding this issue will be available following review and comment on this Addendum RI/FS and the Draft RAP.

6.6.1.8 Alternative 5 - Excavation/On-Site Treatment of Hot Spots with Capping (S-3)

This section evaluates this alternative for operable unit S-3. This alternative includes the following elements:

- Grubbing (removal) of existing vegetation;
- Grading and removal of construction debris;
- Excavation of Hot Spots (Table 15 and Figures 42 through 45);
- Air Monitoring During Remediation;
- Dust Suppression During Remediation;
- On-Site Treatment of Excavated Soil Using Soil Washing for Metals;
- Backfill On-Site Excavation with Treated Soil;
- Installation of an asphalt cap over remaining soil above RAOs;
- Installation of drainage controls;
- Implementation of deed restriction;
- Annual inspection/maintenance of cap; and
- Preparation of annual cap inspection and maintenance report.

Short-Term Effectiveness

The short-term effectiveness of this alternative would be fair. It would result in a temporary increase in dust, noise and traffic congestion on, and in the vicinity of S-3. Dust generation may produce an increase in risk to the public but could be mitigated with dust suppression methods which include air monitoring, water spraying, and use of plans to cease activities during periods of high or unfavorable winds. Noise and traffic congestion are environmental impacts which can be mitigated by conducting excavation and backfilling operations during those hours of the week when most residents are away from home, limiting the number of personal cars brought to the site, use of an off-site staging area for transport vehicles and limiting the amount of equipment brought to or taken from the site on a daily basis.

Long-Term Effectiveness

The long-term effectiveness of this alternative would be good. By removing the highest concentrations of contaminants of concern, significant protection of public health and the environment could be achieved. This action will also eliminate the need for long-term groundwater monitoring.

Reduction of Toxicity, Mobility and Volume

This alternative would reduce the toxicity, mobility and volume of contaminants at the site. Therefore, its ability to satisfy this criteria would be good.

Implementability

The implementability of this alternative is fair. Excavation, backfilling, compaction and groundwater monitoring require the use of proven and well demonstrated technologies and there is an abundance of equipment suppliers and trained operators in the Sacramento area.

Although this alternative proposes to remove and treat existing soil contamination, the likelihood of success is unknown. The feasibility of this technology cannot be fully determined until after treatability studies are completed. However, most work which has been done with this technology has been done for organic contaminants. At this time, other than large scale mining technologies, soil washing is unproven for use on inorganic contaminants, and particularly inorganics present in silty clays similar to this site. In fact, recent experience with removing lead from soil at other UPRR sites indicates that maximum removal efficiencies may be no more than 20 percent. Soil washing systems which have been proposed for this purpose sometimes contain numerous solid-liquid and liquid-liquid separation steps. The more steps used, the higher the costs. Furthermore, soil washing systems frequently generate wastewater which must be discharged under permit, and sludge which requires additional treatment or disposal (GRI, 1987).

In addition, the number of vendors in California which offer full-scale mobile soil washing units is very limited. In fact, there are only about five companies in the United States which have or are in the process of developing this type of technology. However, if treatability studies show that these technologies can be successful, and if reliable vendors can be located, this alternative is likely to secure agency approval and have good administrative feasibility.

The time required to implement this alternative is expected to be approximately 7 months (Table 20). This assumes three months for design, three months for permitting, and four months for excavation and treatment. This assumes an eight-hour work day, five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $845,000 (Table 21 and Appendix G). This includes capital, operation, and maintenance costs. Capital costs are approximately $730,000. Capital costs include the cost for air monitoring, dust suppressing, asphalt capping, excavation, hauling, backfilling and compaction. Operation and maintenance costs are approximately $299,000. Operation and maintenance costs include the cost to operate and maintain one or more soil washing units on-site for three months. No deed restrictions or groundwater monitoring is included in the cost of this alternative.

Compliance with ARARs

The ARARs for this alternative include CEQA; SCAQMD Rules and Regulations; 40 CFR Section 257, 260, 265, and 268; CCR Title 17, 19, 22 and 23 of the California Code of Regulations; California Health and Safety Code; Clear Air Act; and the Clean Water Act. This alternative would comply with all these ARARs. Therefore, its ability to satisfy this criteria is good.

Overall Protection of Human Health and the Environment

This alternative will provide good protection of human health and the environment. It will eliminate direct contact and inhalation exposure pathways and will significantly reduce the potential for migration of contaminants to groundwater. Although implementation of this alternative will result in a temporary increase in dust, noise and traffic, these impacts will be of short duration and can be mitigated through proper design.

State Acceptance

State acceptance of this alternative is currently unknown. However, if this alternative proves to be technically feasible, State acceptance is likely. Additional information regarding this issue will be available following State review of and comment on this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of this alternative is unknown. There have been no formal comments received from the public on this alternative to date. Additional information regarding this issue will be available following review of and comment on this Addendum RI/FS and the Draft RAP.

6.6.1.9 Alternative 6 - Excavation/Off-Site Disposal of Hot Spots with Capping (S-1)

This section evaluates this alternative for operable unit S-1. This alternative includes the following elements:

- Grubbing (removal) of existing vegetation;
- Grading and removal of construction debris;
- Excavation of Hot Spots (Table 15 and Figures 42 through 45);
- Air Monitoring During Remediation;
- Dust Suppression During Remediation;
- Off-Site Disposal of Hot Spot Contamination in Agency-Approved and Permitted Landfill;
- Backfill with Clean Soil, Grade and Compact;
- Installation of an asphalt cap over remaining soils above RAOs;
- Installation of drainage controls;
- Implementation of deed restriction;
- Annual inspection/maintenance of cap; and
- Preparation of annual cap inspection and maintenance report.

Short-Term Effectiveness

The short-term effectiveness of this alternative would be fair. It would result in a temporary increase in dust, noise and traffic congestion on, and in the vicinity of S-1. Dust generation may produce an increase in risk to the public but could be mitigated with dust suppression methods which include air monitoring, water spraying, and use of plans to cease activities during periods of high or unfavorable winds. Noise and traffic congestion are environmental impacts which can be mitigated by conducting excavation and backfilling operations during those hours of the week when most residents are away from home, limiting the number of personal vehicles brought to the site, use of an off-site staging area for transport vehicles and limiting the amount of equipment brought to or taken from the site on a daily basis.

Long-Term Effectiveness

The long-term effectiveness of this alternative would be good. By removing the highest concentrations of contaminants of concern, significant protection of public health and the environment could be achieved. This action will also eliminate the need for long-term groundwater monitoring.

Reduction of Toxicity, Mobility and Volume

This alternative would reduce the mobility and volume of contaminants at the site. It would also reduce the toxicity of contaminants relative to potentially exposed populations. However, while off-site disposal would improve conditions at the site, the same volume and toxicity of contaminants would be transferred to a new location. Therefore, the ability of this alternative to satisfy this criteria is only fair.

Implementability

The implementability of this alternative is good. Excavation, hauling, disposal, backfilling, compaction and groundwater monitoring are all proven and well demonstrated technologies and there is an abundance of equipment suppliers and trained operators in the Sacramento area. Therefore, the technical feasibility of this alternative is good. In addition, the fact that this alternative proposes the removal and off-site storage of the most highly contaminated soil in this operable unit at an agency approved and regulated landfill, means it is likely to secure agency approval and have good administrative feasibility.

The time required to implement this alternative is expected to be approximately 10.5 months (Table 20). The engineering design of the cap will take approximately three months. The permitting process should be completed by the end of that period. Excavation and disposal of the hot spot material and construction of the cap is expected to take approximately 7.5 months, assuming an eight-hour work day, five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately \$6,301,000 (Table 21 and Appendix G). This includes capital and operation and maintenance costs. Capital costs are approximately \$5,932,000. Capital costs include the cost for air monitoring, dust suppression, excavation, hauling, off-site disposal, backfilling and compaction, and asphalt cap installation. Operation and maintenance costs are approximately $1,313,000. Operation and maintenance costs include the cost to inspect and repair the asphalt cap and the cost to submit an annual inspection and maintenance report. These costs were estimated assuming a 5 percent rate of return.

Compliance with ARARs

The ARARs for this alternative include CEQA, 40 CFR Parts 50, 61, 116, 261, and 268; 29 CFR Part 1910; Title 17, 19 and 22 of the California Code of Regulations; Articles 4.5, 5.0, 7.7, and 9.5 of California Health and Safety Code; and Toxic Substances Control Act. This alternative would comply with all these ARARs. Therefore, its ability to satisfy this criteria is good.

Overall Protection of Human Health and the Environment

This alternative will provide good protection of human health and the environment. It will eliminate direct contact and inhalation exposure pathways and will significantly reduce the potential for migration of contaminants to groundwater. Although implementation of this alternative will result in a temporary increase in dust, noise and traffic congestion, these impacts will be of short duration and can be mitigated through proper design.

State Acceptance

State acceptance of this alternative is currently unknown. However, since this alternative provides protection of human health and the environment with a proven technology, State acceptance is likely. Additional information regarding this issue will be available following State review of and comment on this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of this alternative is unknown. There have been no formal comments received from the public on this alternative to date. Additional information regarding this issue will be available following review of and comment on this Addendum RI/FS and the Draft RAP.

6.6.1.10 Alternative 6 - Excavation/Off-Site Disposal of Hot Spots with Capping (S-2)

This section evaluates this alternative for operable unit S-2. This alternative includes the following elements:

- Grubbing (removal) of existing vegetation;
- Grading and removal of construction debris;
- Excavation of Hot Spots (Table 15 and Figures 42 through 45);
- Air Monitoring During Remediation;
- Dust Suppression During Remediation;
- Off-Site Disposal of Hot Spot Contamination in Agency-Approved and Permitted Landfill;
- Backfill with Clean Soil, Grade and Compact;
- Installation of an asphalt cap over remaining soils above RAOs;
- Installation of drainage controls;
- Implementation of deed restriction;
- Annual inspection/maintenance of cap; and
- Preparation of annual cap inspection and maintenance report.

Short-Term Effectiveness

The short-term effectiveness of this alternative would be fair. It would result in a temporary increase in dust, noise and traffic congestion on, and in the vicinity, of S-2. Dust generation may produce an increase in risk to the public but could be mitigated with dust suppression methods which include monitoring, water spraying, and use of plans to cease activities during periods of high or unfavorable winds. Noise and traffic congestion are environmental impacts which can be mitigated by conducting excavation and backfilling operations during those hours of the week when most residents are away from home, limiting the number of personal vehicles brought to the site, use of an off-site staging area for transport vehicles, and limiting the amount of equipment brought to or taken from the site on a daily basis.

Long-Term Effectiveness

The long-term effectiveness of this alternative would be good. By removing the highest concentrations of contaminants of concern, significant protection of public health and the environment could be achieved. This action will also eliminate the need for long-term groundwater monitoring.

Reduction of Toxicity, Mobility and Volume

This alternative would reduce the mobility and volume of contaminants at the site. It would also reduce the toxicity of contaminants relative to potentially exposed populations. However, while off-site disposal would improve conditions at the site, the same volumes and toxicity of contaminants would be transferred to a new location. Therefore, the ability of this alternative to satisfy this criteria is only fair.

Implementability

The implementability of this alternative is good. Excavation, hauling, disposal, backfilling, compaction and groundwater monitoring are all proven and well demonstrated technologies and there is an abundance of equipment suppliers and trained operators in the Sacramento area. Therefore, the technical feasibility of this alternative is good. In addition, the fact that this alternative proposes the removal and off-site storage of the most highly contaminated soil in this operable unit at an agency approved and regulated landfill, means it is likely to secure agency approval and have good administrative feasibility.

The time required to implement this alternative is expected to be approximately ten months (Table 20). The engineering design of the cap will take approximately three months. The permitting process should be completed by the end of that period. Excavation and disposal of the hot spot material and construction of the cap is expected to take approximately 7 months, assuming an eight-hour work day, five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $4,501,000 (Table 21 and Appendix G). This includes capital and operation and maintenance costs. Capital costs are approximately $4,570,000. Capital costs include the cost for air monitoring, dust suppression, excavation, hauling, off-site disposal, backfilling and compaction and asphalt cap installation. Operation and maintenance costs are approximately $298,000. They include the cost to inspect and repair the asphalt cap and the cost to submit an annual inspection and maintenance report. These costs were estimated assuming a 5 percent rate of return.

Compliance with ARARs

The ARARs for this alternative include CEQA, 40 CFR Parts 50, 61, 116, 261, and 268; 29 CFR Part 1910; Title 17, 19 and 22 of the California Code of Regulations; Articles 4.5, 5.0, 7.7, and 9.5 of California Health and Safety Code; and Toxic Substances Control Act. This alternative would comply with all these ARARs. Therefore, its ability to satisfy this criteria is good.

Overall Protection of Human Health and the Environment

This alternative will provide good protection of human health and the environment. It will eliminate direct contact and inhalation exposure pathways and will significantly reduce the potential for migration of contaminants to groundwater. Although implementation of this alternative will result in a temporary increase in dust, noise and traffic, these impacts will be of short duration and can be mitigated through proper design.

State Acceptance

State acceptance of this alternative is currently unknown. However, since this alternative provides protection of human health and the environment with a proven technology, State acceptance is likely. Additional information regarding this issue will be available following State review of and comment on this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of this alternative is unknown. There have been no formal comments received from the public on this alternative to date. Additional information regarding this issue will be available following review and comment on this Addendum RI/FS and the Draft RAP.

6.6.1.11 Alternative 6 - Excavation/Off-Site Disposal of Hot Spots with Capping (S-3)

This section evaluates this alternative for operable unit S-3. This alternative includes the following elements:

- Grubbing (removal) of existing vegetation;
- Grading and removal of construction debris;
- Excavation of Hot Spots (Table 15 and Figures 42 through 45);
- Air Monitoring During Remediation;
- Dust Suppression During Remediation;
- Off-Site Disposal of Hot Spot Contamination in Agency-Approved and Permitted Landfill;
- Backfill with Clean Soil, Grade and Compact;
- Installation of an asphalt cap over remaining soils above RAOs;
- Installation of drainage controls;
- Implementation of deed restriction;
- Annual inspection/maintenance of cap; and
- Preparation of annual cap inspection and maintenance report.

Short-Term Effectiveness

The short-term effectiveness of this alternative would be fair. It would result in a temporary increase in dust, noise and traffic congestion on, and in the vicinity, of S-3. Dust generation may produce an increase in potential risk to the public but could be mitigated with dust suppression methods which include air monitoring, water spraying, and use of plans to cease activities during periods of high or unfavorable winds. Noise and traffic congestion are environmental impacts which can be mitigated by conducting excavation and backfilling operations during those hours of the week when most residents are away from home, limiting the number of personal vehicles brought to the site, use of an off-site staging area for transport vehicles, and limiting the amount of equipment brought to or taken from the site on a daily basis.

Long-Term Effectiveness

The long-term effectiveness of this alternative would be good. It has already been established by the health risk assessment that there is no significant health risk from the soil contaminants on S-3. Therefore, removal of the highest concentrations of contaminants of concern would achieve even greater protection of public health and the environment. This action will eliminate the need for long-term groundwater monitoring.

Reduction of Toxicity, Mobility and Volume

This alternative would reduce the mobility and volume of contaminants at the site. It would also reduce the toxicity of contaminants relative to potentially exposed populations. However, while off-site disposal would improve conditions at S-4, the same volume and toxicity of contaminants would be transferred to a new location. Therefore, the ability of this alternative to satisfy this criteria is only fair.

Implementability

The implementability of this alternative is good. Excavation, hauling, disposal, backfilling, compaction and groundwater monitoring are all proven and well demonstrated technologies and there is an abundance of equipment suppliers and trained operators in the Sacramento area. Therefore, the technical feasibility of this alternative is good. In addition, the fact that this alternative proposes the removal and off-site disposal of contaminated soil at an agency-approved and regulated landfill, means it is likely to secure agency approval and have good administrative feasibility.

The time required to implement this alternative is expected to be approximately 6 months (Table 20). The engineering design of the cap will take approximately three months. The permitting process should be completed by the end of that period. Excavation and disposal of the hot spot material and construction of the cap is expected to take approximately 3 months, assuming an eight-hour work day, five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $804,000 (Table 21 and Appendix G). This includes capital and operation and maintenance costs. Capital costs are approximately $688,000. Capital costs include the cost for air monitoring, dust suppression, excavation, hauling, off-site disposal, backfilling and compaction. Operation and maintenance costs are approximately $299,000. These include the cost to inspect and repair the asphalt cap and the cost to prepare an annual inspection and maintenance report. These costs were estimated assuming a 5 percent rate of return.

Compliance with ARARs

The ARARs for this alternative include CEQA, 40 CFR Parts 50, 61, 116, 261, and 268; 29 CFR Part 1910; Title 17, 19 and 22 of the California Code of Regulations; Articles 4.5, 5.0, 7.7, and 9.5 of California Health and Safety Code; and Toxic Substances Control Act. This alternative would comply with all these ARARs. Therefore, its ability to satisfy this criteria is good.

Overall Protection of Human Health and the Environment

This alternative will provide good protection of human health and the environment. It will eliminate direct contact and inhalation exposure pathways and will significantly reduce the migration of contaminants to groundwater. Although implementation of this alternative will result in a temporary increase in dust, noise and traffic, these impacts will be of short duration and can be mitigated through proper design.

State Acceptance

State acceptance of this alternative is currently unknown. However, since this alternative provides protection of human health and the environment with a proven technology, State acceptance is likely. Additional information regarding this issue will be available following State review of and comment on this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of this alternative is unknown. There have been no formal comments received from the public on this alternative to date. Additional information regarding this issue will be available following review of and comment on this Addendum RI/FS and the Draft RAP.

6.6.1.12 Alternative 10 - Excavation and Off-site Disposal of Soil Above RAOs (S-1)

This section evaluates this alternative for operable unit S-1. This alternative includes the following elements:

- Grubbing (removal) of existing vegetation;
- Grading and removal of construction debris;
- Excavation of Soil Above RAOs (Tables 15 and Figures 16 through 23 and 38 through 41);
- Air Monitoring During Remediation;
- Dust Suppression During Remediation;
- Disposal of Excavated Soil at Off-Site Agency-Approved and Permitted Landfill; and
- Backfill with Clean Soil, Grade and Compact.

Short-Term Effectiveness

The short-term effectiveness of this alternative would be poor. It would result in a temporary increase in dust, noise and traffic congestion on, and in the vicinity, of S-1. Dust generation may produce an increase in risk to the public but could be mitigated with dust suppression methods which include air monitoring, water spraying, and use of plans to cease activities during periods of high or unfavorable winds. Noise and traffic congestion are environmental impacts which could be mitigated by conducting excavation and backfilling operations during those hours of the week when most residents are away from home, limiting the number of personal vehicles brought to the site, use of an off-site staging area for transport vehicles, and limiting the amount of equipment brought to or taken from the site on a daily basis.

Long-Term Effectiveness

The long-term effectiveness of this alternative would be good. By removing all contaminated soil, significant protection of public health and the environment would be provided by this alternative. This action would also eliminate the need for deed restrictions and long-term groundwater monitoring.

Reduction of Toxicity, Mobility and Volume

This alternative would reduce the mobility and volume of contaminants at the site. It would also reduce the toxicity of contaminants relative to potentially exposed populations. However, while off-site disposal would improve conditions at the site, the same volume and toxicity of contaminants would be transferred to a new location. Therefore, the ability of this alternative to satisfy this criteria is only fair.

Implementability

The implementability of this alternative is fair. The technologies which are proposed are proven and well demonstrated. There is an abundance of necessary equipment and skilled operators in the Sacramento area. Thus, the technical feasibility of this alternative is good. However, the duration and magnitude of the excavation which is proposed and the environmental impacts which might result, make agency approval uncertain, and thus the administrative feasibility of this alternative is poor.

The time required to implement this alternative is expected to be approximately ten months (Table 20). It would require approximately two months to complete the engineering design. The permitting process should be completed in approximately three months. Excavation and disposal of the soil contaminated above the RAOs is expected to take approximately 7 months, assuming an eight-hour work day, five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $19,197,000 (Table 21 and Appendix G). This includes only capital costs. After it is implemented, this alternative would provide significant protection of public health and the environment and thus will not require deed restrictions or long-term groundwater monitoring. Thus, the costs for this alternative do not include costs for operation and maintenance. Capital costs include the cost for air monitoring, dust suppression, excavation, hauling, off-site disposal, backfilling and compaction.

Compliance with ARARs

The ARARs for this alternative include CEQA, 40 CFR Parts 50, 61, 116, 261, and 268; 29 CFR Part 1910; Title 17, 19 and 22 of the California Code of Regulations; Articles 4.5, 5.0, 7.7, and 9.5 of California Health and Safety Code; and Toxic Substances Control Act. This alternative would comply with all these ARARs. Therefore, its ability to satisfy this criteria is good.

Overall Protection of Human Health and the Environment

This alternative will provide good protection of human health and the environment. It will eliminate direct contact and inhalation exposure pathways and will significantly reduce the potential for migration of contaminants to groundwater. Although implementation of this alternative will result in a temporary increase in dust, noise and traffic, these impacts will be of short duration and can be mitigated through proper design.

State Acceptance

State acceptance of this alternative is currently unknown. However, since this alternative provides protection of human health and the environment with a proven technology, State acceptance is likely. Additional information regarding this issue will be available following State review of and comment on this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of this alternative is unknown. There have been no formal comments received from the public on this alternative to date. Additional information regarding this issue will be available following review of and comment on this Addendum RI/FS and the Draft RAP.

6.6.1.13 Alternative 10 - Excavation and Off-site Disposal of Soil Above RAOs (S-2)

This section evaluates this alternative for operable unit S-2. This alternative includes the following elements:

- Grubbing (removal) of existing vegetation;
- Grading and removal of construction debris;
- Excavation of Soil Above RAOs (Table 15 and Figures 16 through 23 and 38 through 41);
- Air Monitoring During Remediation;
- Dust Suppression During Remediation;
- Disposal of Excavated Soil at Off-Site Agency-Approved and Permitted Landfill; and
- Backfill with Clean Soil, Grade and Compact.

Short-Term Effectiveness

The short-term effectiveness of this alternative would be poor. It would result in a temporary increase in dust, noise and traffic congestion on, and in the vicinity, of S-2. Dust generation may produce an increase in risk to the public but could be mitigated with dust suppression methods which include air monitoring, water spraying, and use of plans to cease activities during periods of high or unfavorable winds. Noise and traffic congestion are environmental impacts which could be mitigated by conducting excavation and backfilling operations during those hours of the week when most residents are away from home, limiting the number of personal vehicles brought to the site, use of an off-site staging area for transport vehicles, and limiting the amount of equipment brought to or taken from the site on a daily basis.

Long-Term Effectiveness

The long-term effectiveness of this alternative would be good. By removing all contaminated soil, protection of public health and the environment would be provided by this alternative. This action would also eliminate the need for deed restrictions and long-term groundwater monitoring.

Reduction of Toxicity, Mobility and Volume

This alternative would reduce the mobility and volume of contaminants at the site. It would also reduce the toxicity of contaminants relative to potentially exposed populations. However, while off-site disposal would improve conditions at the site, the same volume of contaminants would be transferred to a new location. Therefore, the ability of this alternative to satisfy this criteria is only fair.

Implementability

The implementability of this alternative is fair. The technologies which are proposed are proven and well demonstrated. There is an abundance of necessary equipment and skilled operators in the Sacramento area. Thus, the technical feasibility of this alternative is good. However, the duration and magnitude of the excavation which is proposed and the environmental impacts which might result, make agency approval uncertain, and thus the administrative feasibility of this alternative is poor.

The time required to implement this alternative is expected to be approximately nine months (Table 20). It would require approximately two months to complete engineering design. The permitting process should be completed in approximately three months. Excavation and disposal of the Central Fill Area drums and soil contaminated above the RAOs is expected to take approximately six months, assuming an eight-hour work day, five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $11,247,000 (Table 21 and Appendix G). This includes only capital costs. After it is implemented, this alternative would provide significant protection of public health and the environment and thus will not require deed restrictions or long-term groundwater monitoring. The costs for this alternative do not include charges for operation and maintenance. Capital costs include the cost for air monitoring, dust suppression, excavation, hauling, off-site disposal, backfilling and compaction.

Compliance with ARARs

The ARARs for this alternative include CEQA, 40 CFR Parts 50, 61, 116, 261, and 268; 29 CFR Part 1910; Title 17, 19 and 22 of the California Code of Regulations; Articles 4.5, 5.0, 7.7, and 9.5 of California Health and Safety Code; and Toxic Substances Control Act. This alternative would comply with all these ARARs. Therefore, its ability to satisfy this criteria is good.

This alternative will provide good protection of human health and the environment. It will eliminate direct contact and inhalation exposure pathways and will significantly reduce the potential for migration of contaminants to groundwater. Although implementation of this alternative will result in a temporary increase in dust, noise and traffic, these impacts will be of short duration and can be mitigated through proper design.

Overall Protection of Public Health and the Environment

This alternative will provide good protection of human health and the environment. It will eliminate direct contact and inhalation exposure pathways and will significantly reduce the potential for migration of contaminants to groundwater. Although implementation of this alternative will result in a temporary increase in dust, noise and traffic, these impacts will be of short duration and can be mitigated through proper design.

State Acceptance

State acceptance of this alternative is currently unknown. However, since this alternative provides protection of human health and the environment with a proven technology, State acceptance is likely. Additional information regarding this issue will be available following State review of and comment on this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of this alternative is unknown. There have been no formal comments received from the public on this alternative to date. Additional information regarding this issue will be available following review of and comment on this Addendum RI/FS and the Draft RAP.

6.6.1.14 Alternative 10 - Excavation and Off-site Disposal of Soil Above RAOs (S-3)

This section evaluates this alternative for operable unit S-3. This alternative includes the following elements:

- Grubbing (removal) of existing vegetation;
- Grading and removal of construction debris;
- Excavation of Soil Above RAOs (Tables 15 and Figures 16 through 23 and 38 through 41);
- Air Monitoring During Remediation;
- Dust Suppression During Remediation;
- Disposal of Excavated Soil at Off-Site Agency-Approved and Permitted Landfill; and
- Backfill with Clean Soil, Grade and Compact.

Short-Term Effectiveness

The short-term effectiveness of this alternative would be poor. It would result in a temporary increase in dust, noise and traffic congestion on, and in the vicinity of, S-3. Dust generation may produce an increase in risk to the public but could be mitigated with dust suppression methods which include air monitoring, water spraying, and use of plans to cease activities during periods of high or unfavorable winds. Noise and traffic congestion are environmental impacts which could be mitigated by conducting excavation and backfilling operations during those hours of the week when most residents are away from home, limiting the number of personal vehicles brought to the site, use of an off-site staging area for transport vehicles, and limiting the amount of equipment brought to or taken from the site on a daily basis.

Long-Term Effectiveness

The long-term effectiveness of this alternative would be good. By removing all contaminated soil, significant protection of public health and the environment would be provided by this alternative. This action would also eliminate the need for deed restrictions and long-term groundwater monitoring.

Reduction of Toxicity, Mobility and Volume

This alternative would reduce the mobility and volume of contaminants at the site. It would also reduce the toxicity of contaminants relative to potentially exposed populations. However, while off-site disposal would improve conditions at the site, the same volume of contaminants would be transferred to a new location. Therefore, the ability of this alternative to satisfy this criteria is only fair.

Implementability

The implementability of this alternative is fair. The technologies which are proposed are proven and well demonstrated. There is an abundance of necessary equipment and skilled operators in the Sacramento area. Thus, the technical feasibility of this alternative is good. However, the duration and magnitude of the excavation which is proposed and the environmental impacts which might result, make agency approval uncertain, and thus the administrative feasibility of this alternative is poor.

The time required to implement this alternative is expected to be approximately seven months (Table 20). It would require approximately two months to complete the engineering design. The permitting process should be completed in approximately three months. Excavation and disposal of the soil above the RAOs is expected to take approximately four months, assuming an eight-hour work day, five days per week.

Cost

The total estimated cost of this alternative in 1991 dollars is approximately $4,270,000 (Table 21 and Appendix G). This includes only capital costs. After it is implemented, this alternative would provide significant protection of public health and the environment and thus will not require deed restrictions or long-term groundwater monitoring. The costs for this alternative do not include charges for operation and maintenance. Capital costs include the cost for air monitoring, dust suppression, excavation, hauling, off-site disposal, backfilling and compaction.

Compliance with ARARs

The ARARs for this alternative include CEQA, 40 CFR Parts 50, 61, 116, 261, and 268; 29 CFR Part 1910; Title 17, 19 and 22 of the California Code of Regulations; Articles 4.5, 5.0, 7.7, and 9.5 of California Health and Safety Code; and Toxic Substances Control Act. This alternative would comply with all these ARARs. Therefore, its ability to satisfy this criteria is good.

Overall Protection of Human Health and the Environment

This alternative will provide good protection of human health and the environment. It will eliminate direct contact and inhalation exposure pathways and will significantly reduce the potential for migration of contaminants to groundwater. Although implementation of this alternative will result in a temporary increase in dust, noise and traffic, these impacts will be of short duration and can be mitigated through proper design.

State Acceptance

State acceptance of this alternative is currently unknown. However, since this alternative provides protection of human health and the environment with a proven technology, State acceptance is likely. Additional information regarding this issue will be available following State review of and comment on this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of this alternative is unknown. There have been no formal comments received from the public on this alternative to date. Additional information regarding this issue will be available following review of and comment on this Addendum RI/FS and the Draft RAP.

6.6.1.15 Alternative 10 - Excavation and Off-site Disposal of Soil Above RAOs (S-4)

This section evaluates this alternative for operable unit S-4. This alternative includes the following elements:

- Grubbing (removal) of existing vegetation;
- Grading and removal of construction debris;
- Excavation of Soil Above RAOs (Tables 15 and Figures 16 through 23 and 38 through 41);
- Air Monitoring During Remediation;
- Dust Suppression During Remediation;
- Disposal of Excavated Soil at Off-Site Agency-Approved and Permitted Landfill; and
- Backfill with Clean Soil, Grade and Compact.

Short-Term Effectiveness

The short-term effectiveness of this alternative would be poor. It would result in a temporary increase in dust, noise and traffic congestion on, and in the vicinity of S-4. Dust generation may produce an increase in risk to the public but could be mitigated with dust suppression methods which include air monitoring, water spraying, and use of plans to cease activities during periods of high or unfavorable winds. Noise and traffic congestion are environmental impacts which could be mitigated by conducting excavation and backfilling operations during those hours of the week when most residents are away from home, limiting the number of personal vehicles brought to the site, use of an off-site staging area for transport vehicles, and limiting the amount of equipment brought to or taken from the site on a daily basis.

Long-Term Effectiveness

The long-term effectiveness of this alternative would be good. By removing all contaminated soil, significant protection of public health and the environment would be provided by this alternative. This action would also eliminate the need for deed restrictions and long-term groundwater monitoring.

Reduction of Toxicity, Mobility and Volume

This alternative would reduce the mobility and volume of contaminants in S-4. It would also reduce the toxicity of contaminants relative to potentially exposed populations. However, while off-site disposal would improve conditions at S-4, the same volume of contaminants would be transferred to a new location. Therefore, the ability of this alternative to satisfy this criteria is only fair.

Implementability

The implementability of this alternative is fair. The technologies which are proposed are proven and well demonstrated. There is an abundance of necessary equipment and skilled operators in the Sacramento area. Thus, the technical feasibility of this alternative is good. Furthermore, since this alternative proposes proactive removal of soil contamination, the ability to secure administrative permits and approval should be good.

The time required to implement this alternative is expected to be approximately three and one-half months (Table 20). It would require approximately two months to complete engineering design. The permitting process should be completed in approximately two months. Excavation and disposal of the soil above the RAOs is expected to take approximately six weeks, assuming an eight-hour work day, five days per week.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $155,000 (Table 21 and Appendix G). This includes only capital costs. After it is implemented, this alternative would provide significant protection of public health and the environment and thus will not require deed restrictions or long-term groundwater monitoring. The costs for this alternative do not include charges for operation and maintenance. Capital costs include the cost for air monitoring, dust suppression, excavation, hauling, off-site disposal, backfilling and compaction.

Compliance with ARARs

The ARARs for this alternative include CEQA, 40 CFR Parts 50, 61, 116, 261, and 268; 29 CFR Part 1910; Title 17, 19 and 22 of the California Code of Regulations; Articles 4.5, 5.0, 7.7, and 9.5 of California Health and Safety Code; and Toxic Substances Control Act. This alternative would comply with all these ARARs. Therefore, its ability to satisfy this criteria is good.

Overall Protection of Public Health and the Environment

This alternative will provide good protection of human health and the environment. It will eliminate direct contact and inhalation exposure pathways and will significantly reduce the potential for migration of contaminants to groundwater. Although implementation of this alternative will result in a temporary increase in dust, noise and traffic, these impacts will be of short duration and can be mitigated through proper design.

State Acceptance

State acceptance of this alternative is currently unknown. However, since this alternative provides protection of human health and the environment with a proven technology, State acceptance is likely. Additional information regarding this issue will be available following State review of and comment on this Addendum RI/FS and the Draft RAP.

Community Acceptance

Although no formal comments on this alternative as configured have been received to date from the public, community acceptance of this alternative is likely to be high. At a community meeting held on August 13, 1991 by the Sierra-Curtis Neighborhood Association, several residents voiced concerns about the potential presence of soil contamination in their yards, the potential for contaminant migration from the adjacent UPRR site to their residences, and the potential health effects associated with exposure to contamination from the site. Additional information regarding this issue will be available following review and comment on this Addendum RI/FS and the Draft RAP.

6.6.2 Groundwater Alternatives

Three groundwater alternatives were retained for further consideration as recommended remedial alternatives for each of the operable units identified in Section 6.3.2. These include:

- Alternative 1 - No Action (GW-1 and GW-2);
- Alternative 2 - Limited Action (GW-2 only); and
- Alternative 4 - Extract, Treat and Discharge (GW-1 and GW-2) (Figure 50).

Two pumping scenarios (low flow and high flow) were developed for Alternative 4 for GW-1. Flow rates were estimated using a capture zone analysis for idealized aquifer situations (i.e., homogeneous, isotropic, infinite extent). Data used included slug test results from the RI/FS Report, groundwater gradient based on 1991 water levels (Section 5.1.2), the areal extent of GW-1 (Figure 37), and an assumed thickness for the aquifer zone. Despite the fact that the extent of contamination in the deep zone is not yet known, it is assumed for the purposes of developing cost estimates that the lateral extent of contamination in the deep aquifer zone is the same as in the shallow aquifer.

The low flow scenario includes two extraction wells. One well would be placed at the toe of the plume in the shallow aquifer zone (pumping at 10 gpm). The other well would be placed in the deep aquifer zone (pumping at 10 gpm). The strategy of this scenario is to pump at low flow over a long period of time. It is assumed that pumping will occur for 30 years at the low flow rate.

The high flow scenario includes a total of 10 extraction wells. The extraction wells will be screened in both zones, sealed between zones, and contain two pumps. Each well will pump 10 gpm from each aquifer (i.e., a total of 20 gpm per well). Wells will be placed along the axis of the plume. The strategy of this scenario is to pump at a higher flow over a shorter period of time. It is assumed that pumping will occur for three years at the high flow rate.

Because of the limited amount of groundwater in GW-2, the two flow scenario could not be applied to this operable unit. Therefore, for GW-2 it is assumed that two wells will be pumped at 10 gpm each (20 gpm total) for 3 years.

6.6.2.1 Alternative 1 - No Action (GW-1)

This section evaluates this alternative as it applies to GW-1. This alternative leaves the groundwater in its present condition and applies no remediation to groundwater contamination.

Short-Term Effectiveness

The short-term effectiveness of this alternative would be poor. It would result in continued impact to the environment and creation of potential public health risks due to contaminants in groundwater. Contaminant levels may slowly degrade to below RAOs, but only through natural degradation and diffusion. Assuming the source is contained, the plume would continue to grow though concentrations would decrease.

Long-Term Effectiveness

The long-term effectiveness of this alternative would be poor. It would not protect human health or the environment. It would probably not meet RAOs.

Reduction of Mobility, Toxicity, and Volume

This alternative would not reduce the mobility, toxicity or volume of contamination in this operable unit. Thus, its ability to satisfy this criteria is poor.

Implementability

The implementability of this alternative is poor. Since the alternative proposes no remediation of existing contamination, the chance of agency acceptance, and thus this alternative's administrative feasibility, is poor.

Cost

There are no costs associated with this alternative.

Compliance with ARARs

Chemical-specific ARARs for this alternative include 40 CFR Part 268.43, 141.61, 141.50, 22 CCR 64444.5, and Section 304 of the CWA. Action-specific ARARs for this alternative are 22 CCR 67210, 23 CCR 2550.7, 1550.8, 1550.9, 1550.10, 40 CFR 264.97, 264.98, 264.99, 264.100, and

264.11. There are no location-specific ARARs for this alternative. This alternative would not meet any chemical-specific or action-specific ARARs. Thus, its ability to satisfy this criteria is poor.

Overall Protection of Human Health and Environment

The ability of this alternative to provide overall protection of human health and the environment is poor. It would probably not meet RAOs.

State Acceptance

Based on State comments on the draft RI/FS Report (Dames & Moore, 1990a), acceptance of this alternative is poor. Further information on this issue will be obtained following State review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

The probability of community acceptance of this alternative is unknown. No formal comments on this alternative have been received from the community at this time. Further information on this issue will be obtained following review of and comment on this Addendum RI/FS and the Draft RAP.

6.6.2.2 Alternative 1 - No Action (GW-2)

This section evaluates this alternative as it applies to GW-2. This alternative leaves the groundwater in its present condition and applies no remediation to groundwater contamination.

Short-Term Effectiveness

The short-term effectiveness of this alternative is poor. It would result in continued impact to the environment and creation of potential health risks due to contaminants in groundwater. Contaminant levels may slowly degrade to below RAOs only through natural degradation and diffusion. Assuming the source is contained, the plume would continue to grow though concentrations would decrease.

Long-Term Effectiveness

The long-term effectiveness of this alternative would be poor. It would not protect public health or the environment. It would probably not meet RAOs.

Reduction of Mobility, Toxicity, and Volume

This alternative would not reduce the mobility, toxicity or volume of contamination in this operable unit. Thus, its ability to satisfy this criteria is poor.

Implementability

The implementability of this alternative is poor. Since the alternative proposes no remediation of existing contamination, the chance of agency acceptance, and thus this alternative's administrative feasibility, is poor.

Cost

There are no costs associated with this alternative.

Compliance with ARARs

Chemical-specific ARARs for this alternative include 40 CFR Part 268.43, 141.61, 141.50, 22 CCR 64444.5, and Section 304 of the CWA. Action-specific ARARs for this alternative include CCR 67210, 23 CCR 2550.7, 1550.8, 1550.9, 1550.10, 40 CFR 264.97, 264.98, 264.99, 264.100, and 264.11. There are no location-specific ARARs for the site. This alternative would not meet any chemical-specific or action-specific ARARs. Thus, the ability of this alternative to satisfy this criteria is poor.

Overall Protection of Human Health and Environment

The ability of this alternative to provide overall protection of human health and the environment is poor. Health risks associated with this alternative would not be reduced and RAOs would probably not be met.

State Acceptance

Based on State comments on the draft RI/FS Report, acceptance of this alternative is poor. Further information on this issue will be obtained following State review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

The probability of community acceptance of this alternative is unknown. No formal comments on this alternative have been received from the community at this time. Further information on this issue will be obtained following review of and comment on this Addendum RI/FS and the Draft RAP.

6.6.2.3 Alternative 2 - Limited Action (GW-2)

This section evaluates this alternative as it applies to GW-2. This alternative includes the following elements:

- Limiting Access to Groundwater Through Deed and Drilling Permit Restrictions

- Monitoring Groundwater Using 10 Wells for 30 Years

Short-Term Effectiveness

The short-term effectiveness of this alternative is fair. This alternative may result in continued impact to the environment and creation of potential health risks due to contaminants in groundwater. However, contaminant levels are at or just above RAOs, and it is possible that, over time, natural degradation and dilution may cause concentrations over time to drop below RAOs. This is particularly true if the source of this contamination (i.e., soil contaminants) is eliminated. Public exposure to contaminated groundwater would be controlled by restricted use of the aquifer zone. Ongoing sampling would monitor the contaminant concentrations over time.

Long-Term Effectiveness

The long-term effectiveness of this alternative would be good. Natural degradation and diffusion of contaminants would result in concentrations dropping below RAOs over time. This would provide adequate protection of human health and the environment. Time required for degradation of contaminants below RAOs is unknown at present.

Reduction of Mobility, Toxicity, and Volume

This alternative would not reduce the mobility of contaminants in this operable unit. Over time, it is likely that this alternative would reduce the toxicity and volume of contaminants. Thus, the ability of this alternative to satisfy this criteria is fair.

Implementability

The implementability of this alternative is fair. Technologies for groundwater monitoring are proven and well demonstrated and there is an abundance of required equipment and skilled contractors in the Sacramento area. Furthermore, the addition of drilling permit and/or deed restrictions may make this alternative acceptable to agencies, local authorities, and the public.

It is estimated that it would require approximately nine months to implement this alternative (Table 22). This would include three months to prepare a groundwater monitoring workplan, three months weeks for DTSC review and approval, and approximately six months weeks to implement local restrictions. It is assumed that time for implementing local restrictions (permitting) would start concurrently with DTSC review and approval of the Work Plan.

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $175,700 (Table 23 and Appendix G). Because it is assumed that no treatment is included and that no new wells would need to be installed, the estimated costs of this alternative include only operation and maintenance costs. These costs are based on monitoring approximately 10 wells for 30 years. These costs have been calculated assuming a 5 percent interest rate of return over the life of the project.

Compliance with ARARs

Chemical-specific ARARs for this alternative include 40 CFR Part 268.43, 141.61, 141.50, 22 CCR 64444.5, and Section 304 of the CWA. Action-specific ARARs for this alternative include 22 CCR 67210, 23 CCR 2550.7, 1550.8, 1550.9, 1550.10, 40 CFR 264.97, 264.98, 264.99, 264.100, and 264.11. This alternative would meet chemical-specific ARARs through long-term natural degradation of contaminants. However, because it would not meet action-specific ARARs and because it is unknown how long it would take to meet chemical-specific ARARs, the ability of this alternative to satisfy this criteria is fair.

Overall Protection of Human Health and Environment

The ability of this alternative to provide protection of human health and the environment is good. Health risks and environmental impacts may be reduced by this alternative through the natural degradation of contaminants. In the long-term, RAOs may be met. Public exposure to contaminated groundwater would be minimized through deed and permit restrictions to limit drilling in the aquifer zone.

State Acceptance

Based on State comments on the draft RI/FS Report, acceptance of this alternative is poor. However, additional groundwater monitoring data generated since submittal of the Draft RI/FS Report in August 1990 is now available to support the selection of this alternative for GW-2. Further information on this issue will be obtained following State review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

The probability of community acceptance of this alternative is unknown. No formal comments on this alternative have been received from the community at this time. Further information on this issue will be obtained following review of and comment on this Addendum RI/FS and the Draft RAP.

6.6.2.4 Alternative 4 - Extract, Treat and Discharge (GW-1)

This section evaluates this alternative as it applies to GW-1. This alternative includes the following elements (Figure 50):

- Groundwater Extraction for 3 to 30 Years Using 2 to 10 Off-Site, Downgradient Wells;
- Air Monitoring, Dust Suppression During System Construction;
- Pretreatment of Extracted Groundwater;
- Ex-situ On-Site Treatment of Extracted Groundwater;
- Discharge Treated Water to County POTW via City Sewer Lines;
- Limiting Access to Groundwater through Deed and Drilling Permit Restrictions; and
- Monitor Groundwater Using 30 Wells for 3 to 30 Years (depends on flow rate).

Groundwater extraction wells would be placed off-site. For purposes of this evaluation, it is assumed that 2 to 10 wells would be required. However, the location and number of the wells would be determined during remedial design. It is assumed that pumping rates in the extraction system may range from 20 to 200 gpm. However, an aquifer pump test and groundwater modeling would have to be performed during remedial design to provide the information necessary to accurately estimate pumping rates. Wells would be placed at a location and pumped at a rate which would maximize plume capture and contain contaminant migration.

To install extraction wells in adjacent off-site residential areas, landowner permission may be required. Well permits from Sacramento County Environmental Management Department, Hazardous

Materials Division would also be required. Obtaining permission from different landowners for the installation of off-site extraction wells on private property may complicate the installation process.

Treatment of extracted groundwater is required to reduce levels of contaminants in effluent prior to discharge to the City sewer. The levels of contaminants in discharge effluent will be negotiated with the County POTW, the City Department of Public Works, and the Regional Water Quality Control Board.

In order to improve the efficiency, extend the operating life, and enhance the cost efficiencies of the treatment system, this alternative would include some form of pretreatment. Pretreatment of extracted water would consist of either physical or chemical pretreatment depending on the influent criteria for full-scale on-site ex-situ treatment. The need for and choice of pretreatment systems will also be influenced by the quality of extracted groundwater. One type of pretreatment may consist of filtration to remove suspended solids and fine silt or precipitation to remove dissolved solids, if present. In addition, adjustment of the pH of the water may be needed if an air stripping unit is utilized.

After pretreatment, this alternative would likely include the use of a full-scale on-site ex-situ treatment unit for removal of organic contaminants. Possible treatment technologies may include carbon adsorption, air stripping, or a UV-oxidation system.

Carbon adsorption removes the organic contaminants in extracted groundwater and concentrates them on activated carbon. As the carbon looses its effectiveness, new carbon is exchanged for the spent carbon which is regenerated off-site.

Air stripping removes volatile organic compounds from groundwater through volatilization. Depending on the emission rate of these contaminants, they may need to be collected by activated carbon or destroyed by thermal oxidation. The carbon would require regeneration or disposal off-site.

A UV-oxidation system destroys contaminants through the use of ultra-violet light and an oxidizing chemical such as hydrogen peroxide or ozone. This process produces no residuals.

Carbon adsorption and air stripping are well demonstrated and proven technologies. Once the groundwater plume and aquifer parameters of the deeper aquifer have been more accurately characterized, groundwater models would have to be used to predict the contaminant concentrations in extracted groundwater. This information would then be used to better estimate the size and cost of these treatment systems utilizing these technologies.

UV-oxidation treatment systems are not as well demonstrated. A pilot scale test of this process would have to be conducted in conjunction with a pump test to obtain data necessary to evaluate the feasibility of this type of system.

After treatment, extracted groundwater would be discharged to the City sewer. A permit would have to be obtained from the County of Sacramento, Department of Public Works, Water Quality Division for discharge to the POTW. This permit would outline discharge criteria such as acceptable flow rate and concentration of contaminants. In addition, an MOU would be required by the City of Sacramento to discharge to the City sewer lines. The MOU would specify acceptable time of groundwater discharge and acceptable discharge location. An encroachment permit would have to be obtained from the City to install subsurface piping or wells on City property.

Short-Term Effectiveness

The short-term effectiveness of this alternative is good. The potential health risks to the community and to workers on-site during groundwater extraction would be low. Potential risks from air stripper emissions and spent carbon transported off-site could be easily mitigated. Emissions from the air stripper would be cleaned either by vapor phase carbon or by thermal oxidation. Spent carbon would be manifested, hauled off-site and regenerated or disposed of in a landfill.

Environmental impacts occurring during construction would include the generation of traffic congestion, noise and dust. During system operation, extraction of groundwater would result in a localized reduction of the water table and a change in the direction and velocity of groundwater.

To mitigate traffic and noise impacts, the number of vehicles and equipment allowed at the site would be limited and work would be conducted during weekday hours when residents are likely away from home. To mitigate dust, several methods would be used, such as air monitoring, water spraying, and the use of plans to shut down operations when the direction or speed of existing winds is unfavorable. To mitigate the impact of groundwater extraction, the extraction system would be designed to capture only the groundwater plume and to minimize drawdown.

There would also be potential impacts on the capacity of the City's sewer system and the POTW. Impacts on the sewer might be mitigated by controls (both manual and automatic) to shut pumping down during time of high flow in the sewer. The quantity of discharged water to the POTW would be negligible, totaling about 0.2 percent (at 200 gpm) of the POTW design capacity.

Impacts on traffic and noise from system operation would be negligible with sampling occurring four times a year. Since the treatment system is located on-site, its operation and maintenance would have little impact on neighborhood traffic or noise.

Public exposure to contaminated groundwater would be controlled by restricted use of the aquifer. Ongoing sampling would monitor the clean-up.

Long-Term Effectiveness

The long-term effectiveness of this alternative is good. This alternative would effectively reduce groundwater contaminants to acceptable levels. It would provide adequate protection of human health and the environment and satisfy RAOs. Residuals from the pretreatment process, if produced, would be properly treated or disposed of off-site. It is likely that these residuals would be non-hazardous.

On-site full-scale ex situ treatment may result in spent carbon which must be properly managed. This material would be regenerated off-site by the carbon supplier. This alternative would not leave any untreated wastes or treatment residuals on-site.

Reduction of Toxicity, Mobility, or Volume

The ability of this alternative to satisfy this criteria would be good. It would reduce the mobility, toxicity and volume of groundwater contaminants. Three years of pumping at 200 gpm would extract approximately twice the estimated volume of GW-1, or about 42 million cubic feet of water (315 million gallons). If an average concentration of 0.05 ppm chlorinated solvents (as TCE), and 0.10 ppm aromatic hydrocarbons (as benzene) is assumed, and if the removal efficiency of the treatment system for these contaminants is assumed to be 100 percent, then the total volume of groundwater contaminants to be removed by this alternative would be approximately 400 pounds.

Implementability

The implementability of this alternative is good. The proposed system would be simple to construct, would use equipment and labor available in the Sacramento area, and its performance would be easily monitored. Furthermore, because this alternative proposes removal of contaminated groundwater, it is likely to receive acceptance from agencies, local authorities and the community and to have good administrative feasibility.

It is estimated that it would require 12 months to implement this alternative (Table 22). The tasks required to construct this alternative are listed below along with an estimate of the time for implementation. A work week is assumed to be five working days, each day being eight hours in duration.

Task	Estimated Time
Design	3 months
Permitting	6 months
Construction	3 months

The time required for permitting assumes 3 months would be required for regulatory agency review of permit applications. The time required for construction includes well and pump installation, trenching, pipe installation, wiring, treatment system installation and testing. This estimate is based on the installation of 10 extraction wells (the high flow scenario).

Cost

The total estimated present worth cost of this alternative in 1991 dollars is approximately $978,200 to $3,131,300, (Table 23 and Appendix G), and dependent on flow rate and treatment technology. The total estimated cost includes capital costs and operation and maintenance costs. Capital costs range from $315,250 to $1,708,200, and include extraction well installation, plumbing, pump installation, and treatment system. The least expensive capital costs are for an air stripper at low flow while the high capital cost is for a UV oxidation system at high flow. Operation and maintenance costs range from $1,163,000 to $2,382,000, and include groundwater monitoring, effluent monitoring and treatment system operation. They were estimated assuming a 5 percent interest rate of return over the life of the project. The highest cost is for GAC at high flow while the lowest cost is for air stripping at low flow. Treatment costs, both capital and operation and maintenance, are based on discussions with vendors, assuming the flow rates discussed above. It is assumed that the analytical results which are listed in the RI/FS Report for Well MW-4 will represent influent water (Dames & Moore, 1991f). Trenching costs are based on discussions with a construction contractor estimator. Costs also assume the treatment facility will be located near Well MW-4 and discharge to the POTW will occur at a manhole near the center of the site. Costs are based on extraction of a minimum of 42 million cubic feet of water (315 million gallons) requiring treatment over a 3- or 30-year period. This includes the three on-site, ex-situ treatment technologies combined with two flow rates. Costs assume 2 to 10 wells and a pumping rate of 20 to 200 gpm, respectively.

It is assumed that monitoring of the effluent from the UV/Oxidation and air stripping systems, which are considered as part of Alternative 4, would be conducted weekly for three months, monthly for three months, then quarterly for the life of the system for chlorinated solvents and aromatic hydrocarbons, while monitoring of the GAC system, which is also considered as part of this alternative, would be every 4 to 10 days, depending on the expected time of breakthrough.

Compliance with ARARs

Chemical-specific ARARs for this alternative include 40 CFR Part 61 268.43, 141.61, 141.50, 22 CCR 64444.5, and Section 304 of the CWA. This alternative would meet the chemical-specific ARARs.

Action-specific ARARs for this alternative include 22 CCR 66392.1, 66747, 29 CFR 1910.120, 40 CFR 262.30, 264.273, 264.601, 403.5, 49 CFR 173 and 178, the Designation Level Methodology for Waste Classification and Clean-Up Level Determination (RWQCB, 1989), and Compilation of Water Quality Goals (RWQCB Staff Report by Jon Marshak, October 1990), Sacramento Metropolitan Air Quality Management District Rules and Regulations Sections 301, 301.1 and 302, and Control of Air Emissions for Superfund Air Strippers and Superfund Groundwater Sites (OSWER Directive 9355.0-28). There are no location-specific ARARs. Thus, the ability of this alternative to satisfy this criteria is good.

Overall Protection of Human Health and Environment

The ability of this alternative to provide adequate protection of human health and the environment is good. Groundwater contamination would be significantly reduced. This alternative would satisfy RAOs.

UV oxidation would directly destroy groundwater contaminants. Contaminants on spent carbon from either liquid or vapor phase would be destroyed off-site. Contaminants transferred to air by the air stripper would either be destroyed by thermal oxidation or through carbon regeneration off-site.

There are several potential environmental impacts which could occur. These include noise, dust, traffic congestion, and localized groundwater reduction and modification of flow regime, and increased flow to the sewer and POTW. All of these impacts would be short-term in duration and would either be less than significant or easily mitigated.

State Acceptance

The probability of state acceptance of this alternative is unknown. However, since this alternative uses proven technologies and this alternative will provide protection of human health and the environment and meet the RAOs, State acceptance is likely. Further information on this issue will be obtained following State review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

The probability of community acceptance of this alternative is unknown. Further information on this issue will be obtained following review of and comment on this Addendum RI/FS and the Draft RAP.

6.6.2.5 Alternative 4 - Extract, Treat and Discharge (GW-2)

This section evaluates this alternative as it applies to GW-2. This alternative includes the following elements (Figure 50):

- Groundwater Extraction for 3 Years Using 2 On-site Wells;
- Air Monitoring, Dust Suppression During System Construction;
- Pretreatment of Extracted Groundwater;
- Ex-situ On-Site Treatment of Extracted Groundwater;
- Discharge Treated Water to County POTW via City Sewer Lines;
- Limiting Access to Groundwater through Deed and Drilling Permit Restrictions; and
- Monitor Groundwater Using 10 Wells for 3 Years

The groundwater wells to be used as part of this alternative would be installed on-site. For the purposes of this evaluation, it is assumed that 2 wells would be used. However, the location and number of the wells would be determined during remedial design. The pumping rate of the extraction system to be used is assumed to total about 20 gpm (i.e., 10 gpm per well). However, a pump test and aquifer modeling would have to be performed during remedial design to provide the information to accurately estimate necessary pumping rates. Wells would be installed at a location and pumped at a rate to maximize plume capture and to contain contaminant migration.

Treatment of extracted groundwater is required to reduce levels of contaminants in effluent prior to discharge to the City sewer. The levels of contaminants in discharge effluent will be negotiated with the County POTW, the City Department of Public Works, and the Regional Water Quality Control Board.

In order to improve the efficiency, extend the operating life, and enhance the cost efficiencies of the treatment system, this alternative would include some form of pretreatment. Pretreatment of extracted water would consist of either physical or chemical pretreatment depending on the influent criteria for full-scale on-site ex-situ treatment. The need for and choice of pretreatment systems will also be influenced by the quality of extracted groundwater. One type of pretreatment may consist of filtration to remove suspended solids and fine silt or precipitation to remove dissolved solids, if present. In addition, adjustment of the pH of the water may be needed if an air stripping unit is utilized.

After pretreatment, this alternative would likely include the use of a full-scale on-site, ex-situ treatment unit for removal of organic contaminants. Possible treatment technologies may include carbon adsorption, air stripping, or a UV-oxidation system.

Carbon adsorption removes the organic contaminants in extracted groundwater and concentrates them on activated carbon. As the carbon looses its effectiveness, new carbon is exchanged for the spent carbon which is regenerated off-site.

Air stripping removes volatile organic compounds from groundwater through volatilization. Depending on the emission rate of these contaminants, they may need to be collected by activated carbon or destroyed by thermal oxidation. The carbon would require regeneration or disposal off-site.

A UV-oxidation system destroys contaminants through the use of ultra-violet light and an oxidizing chemical such as hydrogen peroxide or ozone. This process produces no residuals.

Carbon adsorption and air stripping are well demonstrated and proven technologies. Once the groundwater plume and aquifer parameters of the deeper aquifer have been better characterized, groundwater models would have to be used to predict the contaminant concentrations in extracted groundwater. This information would then be used to better estimate the size and cost of these treatment systems utilizing these technologies.

UV-oxidation treatment systems are not as well demonstrated. A pilot scale test of this process would have to be conducted in conjunction with a pump test to obtain data necessary to evaluate the feasibility of this type of system.

After treatment, extracted groundwater would be discharged to the City sewer. A permit would have to be obtained from the County of Sacramento, Department of Public Works, Water Quality Division for discharge to the POTW. This permit would outline discharge criteria such as acceptable flow rate and concentration of contaminants. In addition, an MOU would be required by the City of Sacramento to discharge to the City sewer lines. The MOU would specify acceptable time of groundwater discharge and acceptable discharge location. An encroachment permit would have to be obtained from the City to install subsurface piping or wells on City property.

Short-Term Effectiveness

The short-term effectiveness of this alternative is good. The potential health risks to the community and to workers on-site during groundwater extraction would be low. Potential risks from air stripper emissions and spent carbon transported off-site could be easily mitigated. Emissions from the air stripper would be cleaned either by vapor phase carbon or by thermal oxidation. Spent carbon would be manifested, hauled off-site and regenerated or disposed in a landfill.

Environmental impacts occurring during construction would include the generation of traffic congestion, noise and dust. During system operation, extraction of groundwater would result in a localized reduction of the water table and a change in the direction and velocity of groundwater.

To mitigate traffic and noise impacts, the number of vehicles and equipment which is allowed at the site would be limited and work would be conducted during weekday hours when residents are likely away from home. To mitigate dust, several methods would be used, such as air monitoring, water spraying, and the use of plans to shut down operations when the direction or speed of existing winds is unfavorable. To mitigate the impact of groundwater extraction, the extraction system would be designed to capture only the groundwater plume and to minimize drawdown.

There would also be potential impacts on the capacity of the City's sewer system and the POTW. Impacts on the sewer might be mitigated by controls (both manual and automatic) to shut pumping down during time of high flow in the sewer. The quantity of discharged water to the POTW would be negligible, totaling about 0.02 percent (at 20 gpm) of the POTW design capacity.

Impacts on traffic and noise from system operation would be negligible with sampling occurring four times a year. Since the treatment system is located on-site, its operation and maintenance would have little impact on neighborhood traffic or noise.

Public exposure to contaminated groundwater would be controlled by restricted use of the aquifer. Ongoing sampling would monitor the clean-up.

Long-Term Effectiveness

The long-term effectiveness of this alternative is good. This alternative would effectively reduce groundwater contaminants to acceptable levels. It would provide adequate protection of public health and the environment and satisfy RAOs. Residuals from the pretreatment process, if produced, would be properly treated or disposed off-site. It is likely that these residuals would be non-hazardous.

On-site, full-scale, ex situ treatment may result in spent carbon which must be properly managed. This material would be regenerated off-site by the carbon supplier. This alternative would not leave any untreated wastes or treatment residuals on-site.

Reduction of Mobility, Toxicity, and Volume

The ability of this alternative to satisfy this criteria would be good. It would reduce the mobility, toxicity, and volume of groundwater contaminants. Three years of pumping at 20 gpm would extract 4.2 million cubic feet of water (31.5 million gallons) or about 5 times the volume of GW-2. If an average concentration of 0.005 ppm chlorinated solvents (as TCE) and 0.05 ppm metals (as nickel) is assumed for extracted water over 3 years, and if the removal efficiency of the treatment system for this contamination is assumed to be 100 percent, then the total mass of groundwater contaminants to be removed by this alternative would be about 14 pounds.

Implementability

The implementability of this alternative is good. The proposed system would be simple to construct, would use equipment and labor available in the Sacramento area, and its performance would be easily monitored. Furthermore, because this alternative proposes removal of contaminated groundwater, it is likely to receive acceptance from agencies, local authorities and the community and have good administrative feasibility.

It is estimated that it would require eleven months to implement this alternative (Table 22). The tasks required to construct this alternative are listed below along with an estimate of the time for implementation. A week is assumed to be five working days, each day being eight hours in duration.

Task	Estimated Time
Design	3 months
Permitting	6 months
Construction	2 months

The time required for permitting assumes that 3 months would be required for regulatory agency review of permit applications. The time required for construction includes well and pump installation, trenching, pipe installation, wiring, treatment system installation and testing. This estimate is based on the installation of two extraction wells.

Cost

The total estimated present worth cost of this alternative ranges from approximately $220,400 to $410,000 (Table 23 and Appendix G), depending on treatment technology. The total estimated cost includes capital costs and operation and maintenance costs. Capital costs range from $105,300 to $193,700, and include extraction well installation, plumbing, pump installation, and treatment system. The least expensive capital costs are for an air stripper while the high capital cost is for a UV/oxidation system. Operation and maintenance costs range from $124,400 to $240,500, and include groundwater monitoring, effluent monitoring and treatment system operation. They were estimated assuming a 5 percent interest rate of return over the life of the project. The highest cost is for UV/oxidation while the lowest cost is for air stripping. Treatment costs, both capital and operation and maintenance, are based on discussions with vendors assuming the flow rates discussed above. It is assumed that the analytical results which are listed in the RI/FS Report for Well MW-7 will represent influent water. Costs also assume the treatment facility will be located near Well MW-4 and discharge to the POTW will occur at a manhole near the center of the site. These costs assume two wells pumping at 10 gpm and are based on extraction of about 4.2 million cubic feet of water (31.5 million gallons) over a 3-year period.

It is assumed that monitoring of the effluent from the UV/oxidation and air stripping systems, which are considered as part of Alternative 4, would be conducted weekly for three months, monthly for three months, then quarterly for the life of the system for chlorinated solvents and aromatic hydrocarbons, while monitoring of the GAC system, which is also considered as part of this alternative, would be every 30 days and is dependent on the expected time of breakthrough.

Compliance with ARARs

Chemical-specific ARARs for this alternative include 400 CFR Part 268.43, 141.61, 141.50, 22 CCR 64444.5, and Section 304 of the CWA. This alternative would meet all the chemical-specific ARARs. Action-specific ARARs for this alternative include 22 CCR 66392.1, 66747, 29 CFR 1910.120, 40 CFR 262.30, 264.273, 264.601, 403.5, 49 CFR 173 and 178, the Designation Level Methodology for Waste Classification and Clean-Up Level Determination (RWQCB, 1989), Compilation of Water Quality Goals (RWQCB Staff Report by Jon Marshak, October 1990), Sacramento Metropolitan Air Quality Management District rules and regulations Sections 301, 301.1 and 302, and Control of Air Emissions for Superfund Air Strippers and Superfund Groundwater Sites, OSWER Directive 9355.0-28. There are no location-specific ARARs for this alternative. Thus, the ability of this alternative to satisfy this criteria is good.

Overall Protection of Human Health and Environment

The ability of this alternative to provide adequate protection of human health and the environment is good. Groundwater contamination would be significantly reduced. This alternative would satisfy RAOs.

UV oxidation would directly destroy groundwater contaminants. Contaminants on spent carbon from either liquid or vapor phase would be destroyed off-site. Contaminants transferred to air by the air stripper would either be destroyed by thermal oxidation or through carbon regeneration off-site.

There are several potential environmental impacts which could occur. These include noise, dust, traffic congestion, localized groundwater reduction and modification of flow regime, and increased flow to the sewer and POTW. All of these impacts would be short-term in duration and would either be less than significant or easily mitigated.

State Acceptance

The probability of state acceptance of this alternative is unknown. However, since this alternative uses proven technologies and this alternative will provide protection of human health and the environment and meet the RAOs, State acceptance is likely. Further information on this issue will be obtained following State review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

The probability of community acceptance of this alternative is unknown. No formal comments on this alternative have been received from the community at this time. Further information on this issue will be obtained following review of and comment on this Addendum RI/FS and the Draft RAP.

6.7 COMPARATIVE ANALYSIS AND SELECTION OF ALTERNATIVES

This section presents a comparative analysis of the Final Candidate Alternatives. In Section 6.6, alternatives were evaluated against nine criteria. In this section, the advantages and disadvantages of each alternative with respect to each other are summarized. The discussion is centered on the nine evaluation criteria and divided into six sections corresponding to the four soil operable units and the two groundwater operable units. A summary section follows. Tables 24 and 25 provide a summary of the rating of the alternatives for the operable units using the nine evaluation criteria.

6.7.1 Soil Alternatives

6.7.1.1 Soil Operable Unit S-1

- Alternative 1 — No Action
- Alternative 4 — Containment/Institutional Controls
- Alternative 5 — Excavation/On-Site Treatment of Hot Spots with Capping
- Alternative 6 — Excavation/Off-Site Disposal of Hot Spots with Capping
- Alternative 10 — Excavation/Off-Site Disposal of Soil Above RAOs

Short-Term Effectiveness

Alternative 4 is the least disruptive remedial alternative, with the exception of the No Action Alternative, and would therefore be the best alternative in terms of community and worker protection. Alternatives 5 and 6 offer the next best short-term effectiveness, although there would be minor environmental impacts (noise, dust, traffic) during excavation and construction activities; dust control measures and access restrictions would minimize potential risks. Alternative 10 would provide the least short-term effectiveness because it involves the largest amount of soil to be handled, and the potential environmental impacts are therefore greater on the short-term. However, as in the case of other alternatives, measures would be taken to minimize potential risks.

Long-Term Effectiveness and Permanence

Alternative 10 is the most reliable of the three alternatives, since the contaminants are securely contained in a facility which is designed to be monitored. Under Alternative 5, the highest concentrations of contaminants in soils (hot spots) would be brought to the surface for treatment and testing, so this alternative offers the ability for a more permanent solution to the hot spot soils and for monitoring the effectiveness of remediation. Alternative 6 provides for removal of hot spots and containment in a disposal facility, which, as in Alternative 10, is a reliable remedial alternative, but requires long-term monitoring and maintenance of the disposal facility. Both Alternatives 5 and 6 additionally provide for capping, and deed and access restrictions to control exposure pathways and manage residual risk on-site. Alternative 4 provides for containment of all contaminants in soil in Operable Unit S-1 through capping, and deed and access restrictions to control exposure pathways and manage residual risk, and groundwater monitoring to evaluate the long-term adequacy of the cap. The long-term effectiveness of all of these alternatives, with the exception of the No Action Alternative, is considered equally good; however, Alternative 5 provides the most permanent solution to remediation.

Reduction of Toxicity, Mobility, and Volume

Alternative 5 provides the greatest reduction in contaminant toxicity, mobility, and volume through treatment. Alternative 10 provides for reduction in on-site contaminant toxicity, mobility, and volume by excavation and off-site disposal, as does Alternative 6, but less so than Alternative 10. Alternative 4 provides reduction only in contaminant mobility through limiting infiltration via a cap. Alternative 1 provides no reduction in contaminant toxicity, mobility, or volume.

Implementability

All of the alternatives, with the exception of Alternative 1, are administratively and technically feasible, although Alternative 5 is less feasible technically than the other alternatives; treatability studies would need to be completed. Therefore, Alternative 5 is the least implementable. Technically and logistically, the remaining alternatives are increasingly difficult to implement and complete in the following order: 4, 6, and 10. The easiest alternative to implement, therefore, is Alternative 4, followed by alternative 6 and then Alternative 10. Alternative 1 is not administratively feasible, and not implementable.

Cost

With the exception of Alternative 1, the cost of Alternative 6 is the lowest, followed in order by Alternatives 4, 5, and 10. Alternative 10 is significantly more costly than Alternative 6.

Compliance with ARARs

All but the No Action Alternative are designed to meet contaminant-specific and action-specific ARARs. Since Alternative 5 involves treatment and treatability studies have not been completed, there is a possibility that this alternative may not meet all the ARARs. Therefore, Alternatives 4, 6, and 10 provide the greatest and equal compliance with ARARs, followed by Alternative 5.

Overall Protection of Human Health and the Environment

Alternative 10 provides the greatest overall protection of human health and the environment by removing all contaminants from the site to a disposal facility designed to be monitored. In decreasing order, Alternatives 5, 6, and 4 provide slightly less protection than Alternative 10 to human health and the environment, because of uncertainties in containment and monitoring effectiveness exist.

State Acceptance

The probability of State acceptance of these alternatives is unknown. However, since Alternatives 4, 6, and 10 use proven technologies, comply with ARARs, and meet RAOs, State acceptance is likely. Treatability studies are required to demonstrate the effectiveness of this technology on-site for Alternative 5. Further information on these issues will be obtained following State review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of the final candidate alternatives for this operable unit is unknown pending review of and comment on this Addendum RI/FS and the Draft RAP.

Recommended Remedial Alternative

The recommended remedial alternative for soil Operable Unit S-1 is Alternative 4 — Containment with Institutional Controls.

6.7.1.2 Soil Operable Unit S-2

- Alternative 1 — No Action
- Alternative 6 — Excavation/Off-Site Disposal with Capping
- Alternative 10 — Excavation/Off-Site Disposal of Soil Above RAOs

Short-Term Effectiveness

Alternative 1 is the least disruptive and therefore would be the best alternative in terms of community and worker protection during implementation. Alternative 6 involves excavation of less soil and involves less time than Alternative 10, so Alternative 6 provides better community and worker protection over the short-term implementation time than Alternative 10.

Long-Term Effectiveness

Alternative 10 will greatly minimize potential risks through a reliable technology, since the contaminants will be secured in a disposal facility off-site which is designed for monitoring. However, long-term management and maintenance of the off-site disposal facility is required. Alternative 6 uses the same technology as Alternative 10, but removes the most contaminated soil to a disposal facility, and requires maintenance of both the site and the disposal facility. Therefore, Alternative 6 may be less effective over the long-term than Alternative 10 off-site. The No Action Alternative would be the least effective remedial alternative in the long term.

Reduction of Toxicity, Mobility, and Volume

Alternative 10 provides the greatest on-site reduction of contaminant toxicity and volume, and controls contaminant mobility. Since Alternative 6 removes hot spots, it provides significant reduction in contaminant toxicity and volume, and capping as well as landfill disposal controls for contaminant mobility. Alternative 1 provides no reduction in contaminant toxicity, volume or mobility.

Implementability

Both Alternatives 6 and 10 are technically feasible, although Alternative 10 would require more time to implement. Additionally, it may be technically more feasible to excavate the hot spot areas than excavation of areas to RAOs which are lower levels of contaminants. Both Alternatives 6 and 10 would administratively be equally feasible, while Alternative 1 would not be administratively feasible. Therefore, Alternative 6 would be the most implementable alternative, followed by Alternative 10.

Cost

With the exception of Alternative 1, the cost of Alternative 6 is the lowest, followed in order by Alternatives 4, 5, and 10. Alternative 10 is significantly more costly than Alternative 6.

Compliance with ARARs

Both Alternatives 6 and 10 comply with ARARs, while Alternative 1 does not.

Overall Protection of Human Health and the Environment

Both Alternatives 6 and 10 provide good protection of human health and the environment. Alternative 6 provides reduction in contaminant volume and toxicity by removal of hot spots, and pathway control through capping. Alternative 10 provides removal of contamination. However, Alternative 6 may offer slightly less protection of environment through uncertainties in containment and monitoring effectiveness. Alternative 1 offers significantly less protection through deed and access restrictions and groundwater monitoring.

State Acceptance

The probability of State acceptance of these alternatives is unknown. However, since Alternatives 6 and 10 use proven technologies, comply with ARARs, and meet RAOs, State acceptance is likely. Further information on these issues will be obtained following State review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of the final candidate alternatives for this operable unit is unknown pending review of and comment on this Addendum RI/FS and the Draft RAP.

Recommended Remedial Alternative

The recommended remedial alternative for Operable Unit S-2 is Alternative 6 — Excavation/Off-Site Disposal with Capping.

6.7.1.3 Soil Operable Unit S-3

- Alternative 1 — No Action
- Alternative 4 — Containment/Institutional Controls
- Alternative 5 — Excavation/On-Site Treatment of Hot Spots with Capping
- Alternative 6 — Excavation/Off-Site Disposal of Hot Spots with Capping
- Alternative 10 — Excavation/Off-Site Disposal of Soil Above RAOs

Short-Term Effectiveness

Alternative 4 is the least disruptive remedial alternative, with the exception of the No Action Alternative, and would therefore be the best alternative in terms of community and worker protection. Alternatives 5 and 6 offer the next best short-term effectiveness, although there would be minor environmental impacts (noise, dust, traffic) during excavation and construction activities; dust control measures and access restrictions would minimize potential risks. Alternative 10 would provide the least short-term effectiveness because it involves the largest amount of soil to be handled, and the potential environmental impacts are therefore greater on the short-term. However, as in the case of other alternatives, measures would be taken to minimize potential risks.

Long-Term Effectiveness and Permanence

Alternative 10 is the most reliable of the three alternatives, since the contaminants are securely contained in a facility which is designed to monitor. Under Alternative 5, the highest concentrations of contaminants in soils (hot spots) would be brought to the surface for treatment and testing, so this alternative offers the ability for a more permanent solution to the hot spot soils and for monitoring the effectiveness of remediations. Alternative 6 provides for removal of hot spots and containment in a disposal facility, which, as in Alternative 10, is a reliable remedial alternative, but requires long-term monitoring and maintenance of the disposal facility. Both Alternatives 5 and 6 additionally provide for capping, and deed and access restrictions to control exposure pathways and manage residual risk on-site. Alternative 4 provides for containment of all contaminants in soil in Operable Unit S-3 through capping, and deed and access restrictions to control exposure pathways and manage residual risk, and groundwater monitoring to evaluate the long-term adequacy of the cap. The long-term effectiveness of all of these alternatives, with the exception of the No Action Alternative, is considered equally good; however, Alternative 5 provides the most permanent solution to remediation.

Reduction of Toxicity, Mobility, and Volume

Alternative 5 provides the greatest reduction in contaminant toxicity, mobility, and volume through treatment. Alternative 10 provides for reduction in on-site contaminant toxicity, mobility, and volume by excavation and off-site disposal, as does Alternative 6, but less so than Alternative 10. Alternative 4 provides reduction only in contaminant mobility through limiting infiltration via a cap. Alternative 1 provides no reduction in contaminant toxicity, mobility, or volume.

Implementability

All of the alternatives, with the exception of Alternative 1, are administratively and technically feasible, although Alternative 5 is less feasible technically than the other alternatives; treatability studies would need to be completed. Therefore, Alternative 5 is the least implementable. Technically and logistically, the remaining alternatives are increasingly difficult to implement and complete in the following order: 4, 6, and 10. The easiest alternative to implement, therefore, is Alternative 4, followed by alternative 6 and then Alternative 10. Alternative 1 is not administratively feasible, and not implementable.

Cost

With the exception of Alternative 1, the cost of Alternative 6 is the lowest, followed in order by Alternatives 4, 5, and 10. Alternative 10 is significantly more costly than Alternative 6.

Compliance with ARARs

All but the No Action Alternative are designed to meet contaminant-specific and action-specific ARARs. Since Alternative 5 involves treatment and treatability studies have not been completed, there is a possibility that this alternative may not meet all the ARARs. Therefore, Alternatives 4, 6, and 10 provide the greatest and equal compliance with ARARs, followed by Alternative 5.

Overall Protection of Human Health and the Environment

Alternative 10 provides the greatest overall protection of human health and the environment by removing all contaminants from the site to a disposal facility designed to be monitored. In decreasing order, Alternatives 5, 6, and 4 provide slightly less protection than Alternative 10 to human health and the environment, because of uncertainties in containment and monitoring effectiveness exist.

State Acceptance

The probability of State acceptance of these alternatives is unknown. However, since Alternatives 4, 6, and 10 use proven technologies, comply with ARARs, and meet RAOs, State acceptance is likely. Treatability studies are required to demonstrate the effectiveness of this technology on-site for Alternative 5. Further information on these issues will be obtained following State review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of the final candidate alternatives for this operable unit is unknown pending review of and comment on this Addendum RI/FS and the Draft RAP.

Recommended Remedial Alternative

The recommended remedial alternative for soil Operable Unit S-3 is Alternative 6 — Excavation/Off-Site Disposal of Hot Spots with Capping.

6.7.1.4 Soil Operable Unit S-4

- Alternative 1 — No Action
- Alternative 10 — Excavation/Off-Site Disposal of Soil Above RAOs

Short-Term Effectiveness

Measures to minimize and maintain dust emissions during implementation of Alternative 10 will be provided, and potential environmental impacts will be minimal largely because the volume to be removed is small. Alternative 10 therefore offers comparable short-term effectiveness without significant disadvantages in comparison to the No Action Alternative.

Long-Term Effectiveness

Alternative 10 will greatly minimize potential risks through a reliable technology, since the contaminants will be secured in a facility which is designed for monitoring. However, long-term management and maintenance of the facility is required. Alternative 1 offers no reduction of potential risk.

Reduction of Toxicity, Mobility, and Volume

On-site toxicity and volume will be reduced and mobility will be controlled by Alternative 10. Alternative 1 offers no reduction of toxicity, mobility, or volume.

Implementability

Alternative 10 is technically very feasible, and administratively more acceptable than Alternative 1, and therefore Alternative 10 is more implementable than Alternative 1.

Cost

The estimated cost of Alternative 1 is significantly less than the estimated cost of Alternative 10.

Compliance with ARARs

Alternative 10 complies with ARARs and Alternative 1 does not comply with ARARs.

Overall Protection of Human Health and the Environment

Alternative 10 provides good protection of human health and the environment. Alternative 1 provides less protection of human health and the environment through access restrictions and groundwater monitoring. It should be noted that the potential risks of adverse health effects due to contaminants in soil Operable Unit S-4 are not considered significant (DTSC, 1991).

State Acceptance

The DTSC has directed UPRR to implement interim remedial measures in Operable Unit S-4, and therefore, the State has accepted Alternative 10 over Alternative 1.

Community Acceptance

At a public meeting in August 1991, the community accepted Alternative 10 as the preferred alternative.

Recommended Remedial Alternative

The recommended remedial alternative for Operable Unit S-4 is Alternative 10 — Excavation/Off-Site Disposal of Soil Above RAOs.

6.7.2 Groundwater Alternatives

6.7.2.1 Groundwater Operable Unit GW-1

- Alternative 1 — No Action
- Alternative 4 — Extract/Treat/Discharge

Short-Term Effectiveness

The short-term effectiveness of the No Action Alternative (1) is better than Alternative 4, since no construction activities or groundwater extraction is involved and there are no corresponding potential environmental impacts associated with implementation.

Long-Term Effectiveness and Permanence

The long-term effectiveness is better for Alternative 4 than Alternative 1 because Alternative 4 removes contaminants from the groundwater and Alternative 1 leaves contaminants in place. However, Alternative 4 will require engineering and maintenance controls over a potentially long period of time.

Reduction of Toxicity, Mobility, and Volume

Alternative 4 will reduce toxicity, mobility, and volume, whereas Alternative 1 will not reduce toxicity, mobility, or volume of contaminants.

Implementability

Alternative 4 uses a proven technology that is easy to implement; however, some cooperation may be required from off-site landowners for groundwater remedial system installation. Alternative 1 is logistically the easiest to implement. However, Alternative 4 is administratively more acceptable than Alternative 1, and Alternative 4 is therefore more implementable than Alternative 1.

Cost

The estimated cost of Alternative 1 is significantly less than Alternative 4.

Compliance with ARARs

Alternative 4 complies with ARARs and Alternative 1 does not comply with ARARs.

Overall Protection of Human Health and the Environment

Alternative 1 provides no protection of human health and the environment, and Alternative 4 provides good protection of human health and the environment.

State Acceptance

Based on DTSC comments provided on the Draft RI/FS Report (Dames & Moore, 1991a), the acceptance of Alternative 1 would be poor. Since Alternative 4 uses proven technologies, will provide protection of human health and the environment, and will meet the RAOs, State acceptance of Alternative 4 is likely to be good. Further information on this issue will be obtained following State review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of the final candidate alternatives for this operable unit is unknown pending review of and comment on this Addendum RI/FS and the Draft RAP.

Recommended Remedial Alternative

The recommended remedial alternative for Operable Unit GW-1 is Alternative 4 — Extract/Treat/Discharge.

6.7.2.2 Groundwater Operable Unit GW-2

- Alternative 1 — No Action
- Alternative 2 — Limited Action
- Alternative 4 — Extract/Treat/Discharge

Short-Term Effectiveness

The short-term effectiveness of the No Action Alternative (1) and Alternative 2 is better than Alternative 4 since no construction activities or groundwater extraction is involved and there are no corresponding potential environmental impacts associated with implementation.

Long-Term Effectiveness and Permanence

The long-term effectiveness of Alternative 4 is better than that of Alternative 2 which is better than that of Alternative 1. Alternative 4 removes contaminants from groundwater and Alternatives 1 and 2 leave contaminants in place. However, Alternative 4 will require engineering and maintenance controls over a several-year period. Alternative 2 requires monitoring over an even longer period of time.

Reduction of Toxicity, Mobility, and Volume

Alternative 4 will reduce toxicity, mobility, and volume of contaminants, whereas neither Alternative 1 nor Alternative 2 involve treatment to actively reduce toxicity, mobility, or volume of contaminants. Alternative 2 involves reduction of contaminant toxicity, mobility, and volume through natural degradation over time.

Implementability

Technologically and logistically, Alternative 1 is easier to implement than Alternative 2 which is easier to implement than Alternative 4. Alternatives 2 and 4 use proven technologies that are relatively easy to implement. Alternatives 2 and 4 are administratively more acceptable than Alternative 1. Therefore, Alternative 2 will be overall the easiest to implement.

Cost

The estimated cost for Alternative 4 is greater than Alternative 2 which is greater than Alternative 1.

Compliance with ARARs

Alternative 4 would comply with all ARARs, Alternative 2 would comply with chemical-specific but not action-specific ARARs, and Alternative 1 would not comply with ARARs.

Overall Protection of Human Health and the Environment

Alternative 1 provides no protection of human health and the environment, and both Alternatives 2 and 4 provide equally good protection of human health and the environment.

State Acceptance

Based on DTSC comments provided on the Draft RI/FS Report (Dames & Moore, 1991a), the acceptance of both Alternatives 1 and 2 is poor. However, additional groundwater monitoring data generated since submittal of the Draft RI/FS Report in August 1990 is now available to support selection of Alternative 2. Since Alternative 4 uses proven technologies, will provide protection of human health and the environment, and will meet the RAOs, State acceptance of Alternative 4 is likely to be good. Further information on these issues will be obtained following State review of this Addendum RI/FS and the Draft RAP.

Community Acceptance

Community acceptance of the final candidate alternatives for this operable unit is unknown pending review of and comment on this Addendum RI/FS and the Draft RAP.

Recommended Remedial Alternative

The recommended remedial alternative for Operable Unit GW-2 is Alternative 2 — Limited Action.

6.7.3 Summary

After completion of the detailed analysis of final candidate alternatives, and comparison of final candidate alternatives to identify relative advantages and disadvantages, the following remedial alternatives for the soil and groundwater operable units were recommended:

- Soil Operable Unit S-1: Alternative 4 - Containment with Institutional Controls;

- Soil Operable Unit S-2: Alternative 6 - Excavation/Off-Site Disposal of Hot Spots with Capping;

- Soil Operable Unit S-3: Alternative 6 - Excavation/Off-Site Disposal of Hot Spots with Capping;

- Soil Operable Unit S-4: Alternative 10 - Excavation/Off-Site Disposal of Soil Above RAOs;

- Groundwater Operable Unit GW-1: Alternative 4 - Extract, Treat and Discharge; and

- Groundwater Operable Unit GW-2: Alternative 2 - Limited Action.

These alternatives for the various soil and groundwater operable units were chosen because they effectively address all exposure pathways that were identified in the Revised Baseline Health Risk Assessment (Appendix J); the alternatives use proven, reliable and well demonstrated technologies, and are easy to install and maintain. Summary details of the selected alternative for each operable unit are discussed in Sections 6.1 through 6.5.

Presented in the following section is a summary of the comparison of the alternatives and a brief description of the elements of the recommended remedial alternatives for the site. More detailed information regarding the technical, regulatory and administrative requirements which must be met by these alternatives will be included in the Draft RAP. The purpose of the Draft RAP will be to provide the public with an opportunity to review and comment on the recommended remedial alternatives for the site prior to design and implementation.

6.7.3.1 Soil Alternatives

Soil Operable Unit S-1: Alternative 4 - Containment with Institutional Controls

This recommended remedial alternative includes containment through the installation of an asphalt cap across the surface area of soil Operable Unit S-1 to reduce the vertical infiltration of rainwater, and eliminate potential exposure pathways. This alternative also includes 30 years of groundwater monitoring and deed and access restrictions (fencing).

Because containment using a cap does not include excavation, it provides better short-term protection of human health and the environment than any other final candidate alternative except for the

No Action Alternative. It also provides good long-term and overall protection of human health and the environment, satisfies RAOs and complies with ARARs. The technical feasibility is good because it uses a proven and easy to implement technology. It is also more cost effective than any other final candidate alternative for soil except for the No Action alternative. The Containment Alternative complies with the provisions of the National Contingency Plan (40 CFR 300.430(e)(3)(ii)) for remediation of Superfund sites which require consideration of one or more alternatives that involve little or no treatment, but provide protection of human health and the environment primarily by preventing or controlling exposure to hazardous substances, pollutants, or contaminants, through engineering controls, containment, and as necessary, institutional controls.

Containment using an engineered cap would require approximately ten months to design and construct. This includes three months to design, three months to permit, and seven months to construct. Other components of this alternative include annual cap inspection and groundwater monitoring for 30 years and preparation of an annual groundwater monitoring and cap inspection report.

Soil Operable Unit S-2: Alternative 6 - Excavation/Off-Site Disposal of Hot Spots with Capping

This recommended remedial alternative includes excavation and off-site disposal of buried drums and hot spots in soil Operable Unit S-2 to eliminate potential exposure pathways, reduce the mobility of contaminants, and reduce the potential for contaminant migration to groundwater. It includes installing an asphalt cap on those areas of the operable unit which are not excavated, and deed and access restrictions (fencing).

While excavation results in a short-term immediate potential increase in health risks or impacts, the long-term effectiveness provided by this alternative is better than any of the other final candidate alternatives except complete excavation because of the removal of contaminants and potential sources of groundwater contamination. It would satisfy RAOs and comply with ARARs. The technical feasibility of this alternative is good because it uses a proven and easy to implement technology. In addition, it is more cost effective than any other final candidate alternative except for the No Action alternative. The Excavation/Off-Site Disposal of Hotspots Alternative complies with the provisions of the National Contingency Plan (40 CFR 300.430(e)(3)(ii)) for remediation of Superfund sites which require consideration of one or more alternatives that involve little or no treatment, but provide protection of human health and the environment primarily by preventing or controlling exposure to hazardous substances, pollutants, or contaminants, through engineering controls, and as necessary, institutional controls.

Excavation and disposal of hot spots off-site would require approximately ten months to complete. This includes three months for design, three months for permitting and seven months for construction.

Soil Operable Unit S-3: Alternative 6 - Excavation/Off-Site Disposal of Hot Spots with Capping

This recommended remedial alternative includes excavation and off-site disposal of soil hot spots in Operable Unit S-3 to eliminate potential exposure pathways, reduce the mobility of contaminants, and reduce the potential for contaminant migration to groundwater. It includes installing an asphalt cap on those areas of the operable unit which are not excavated, and deed and access restrictions (fencing).

While excavation results in an immediate, short-term, potential increase in health risks or impacts, the long-term effectiveness provided by this alternative is better than any of the other final candidate alternatives except complete excavation because of the removal of contaminants and potential sources of groundwater contamination. It would satisfy RAOs and comply with ARARs. The technical feasibility of this alternative is good because it uses a proven and easy to implement technology. In addition, it is more cost effective than any other final candidate alternative except for the No Action alternative. The Excavation/Off-Site Disposal of Hotspots Alternative complies with the provisions of the National Contingency Plan (40 CFR 300.430(e)(3)(ii)) for remediation of Superfund sites which require consideration of one or more alternatives that involve little or no treatment, but provide protection of human health and the environment primarily by preventing or controlling exposure to hazardous substances, pollutants, or contaminants, through engineering controls, and as necessary, institutional controls.

Excavation and off-site disposal of hot spots would require approximately six and one-half months to complete. This includes two months for design, three months for permitting, and three and one-half months for excavation, backfilling and capping.

Soil Operable Unit S-4: Alternative 10 - Excavation/Off-Site Disposal of Soil Above RAOs

This recommended remedial alternative includes excavation and off-site disposal of all soil above RAOs in Soil Operable Unit S-4 to eliminate potential exposure pathways, reduce the mobility of contaminants, and reduce potential for contaminant migration to groundwater.

While excavation results in an immediate, short-term, potential increase in health risks or impacts, the long-term effectiveness provided by this alternative is better than any of the other final candidate alternatives because of the removal of contaminants. The technical feasibility of this alternative is good because it uses a proven and easy to implement technology. It would satisfy RAOs and comply with ARARs. Furthermore, based on the results of recent public meetings, community acceptance of this alternative is expected to be good. The Excavation and Off-Site Disposal of Soil Above RAOs alternative complies with the provisions of the National Contingency Plan (40 CFR 300.430(e)(3)(ii)) for remediation of Superfund sites which require consideration of one or more alternatives that involve little or no treatment, but provide protection of human health and the environment primarily by preventing or controlling exposure to hazardous substances, pollutants, or contaminants, through engineering controls, and as necessary, institutional controls.

Excavation and off-site disposal of soil above RAOs would require approximately three and one-half months to complete. This includes two months for design, two months to obtain the necessary permits, and one and one-half months for excavation, backfilling and capping.

6.7.3.2 Groundwater Alternatives

Groundwater Operable Unit GW-1 : Alternative 4 - Extract, Treat and Discharge

This recommended remedial alternative includes groundwater extraction, pretreatment (if necessary), and discharge of groundwater to the County POTW via City sewer lines. It includes restricted access to groundwater and groundwater monitoring during system operation.

While there would be short-term impacts during construction and system operation, these impacts would be minor and would be out-weighed by long-term advantages of meeting RAOs for groundwater. The technical feasibility of this alternative is good because it uses proven technologies. This alternative would comply with ARARs. It would significantly reduce the toxicity, mobility, and volume of contaminants. The Extract/Treat/Reclaim alternative complies with the provisions of the National Contingency Plan (40 CFR 300.430(e)(4) for remediation of Superfund sites which require consideration of groundwater remedial alternatives that attain site-specific remediation levels within different restoration time periods utilizing one or more technologies.

The groundwater extraction, treatment and discharge system would require approximately twelve months to design and construct. This includes three months for design, six months for permitting, and three months for construction. Depending on the number of wells and the flow rate, it may take between 3 and 30 years for this alternative to meet RAOs.

Groundwater Operable Unit GW-2 : Alternative 2 - Limited Action

This recommended remedial alternative includes groundwater monitoring for 30 years. It also includes restricted access to groundwater by means of deed restrictions and limited issuance of drilling permits.

Because limited action does not include extraction and/or treatment it provides better short-term protection of public health and the environment than any other final candidate alternative. The long-term effectiveness is also good because contaminants in this operable unit are only slightly higher than RAOs and are expected to dissipate with time. The technical feasibility of this alternative is good because it uses proven technologies. This alternative would reduce the toxicity, mobility, and volume of contaminants. In addition, it is more cost effective than any other final candidate alternative except the No Action alternative. The Limited Action alternative complies with the provisions of the National Contingency Plan (40 CFR 300.430(e)(4) for remediation of Superfund sites which require consideration of groundwater remedial alternatives that attain site-specific remediation levels within different restoration time periods utilizing one or more technologies.

The limited action alternative would require approximately nine months to design and implement. This includes three months for preparation of a groundwater monitoring work plan, three months for agency review and approval, and six months to implement deed and well permit restrictions. This alternative includes 30 years of groundwater monitoring.

7.0 REFERENCES

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TABLES

TABLE 1 (Continued)
SUMMARY SOIL ANALYTICAL RESULTS
ASBESTOS (%)
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

COORDINATE	DEPTH (ft bgs)	RESULTS	COORDINATE	DEPTH (ft bgs)	RESULTS
GRID SAMPLES					
350E, 500N	0.0 - 0.5	—	410E, 540N	0.0 - 0.5	5.0%
350E, 500N	0.5 - 1.0	0.1%	410E, 540N	0.5 - 1.0	—
350E, 520N	0.0 - 0.5	—	410E, 560N	0.0 - 0.5	2.0%
350E, 520N	0.5 - 1.0	—	410E, 560N	0.5 - 1.0	0.2%
350E, 540N	0.0 - 0.5	—	410E, 580N	0.0 - 0.5	0.1%
350E, 540N	0.5 - 1.0	—	410E, 580N	0.5 - 1.0	2.0%
350E, 560N	0.0 - 0.5	—	430E, 480N	0.0 - 0.5	1.0%
350E, 560N	0.5 - 1.0	—	430E, 480N	0.5 - 1.0	0.1%
350E, 580N	0.0 - 0.5	—	430E, 500N	0.0 - 0.5	0.1%
350E, 580N	0.5 - 1.0	—	430E, 500N	0.5 - 1.0	—
370E, 480N	0.0 - 0.5	0.3%	430E, 520N	0.0 - 0.5	0.1%
370E, 480N	0.5 - 1.0	0.1%	430E, 520N	0.5 - 1.0	0.1%
370E, 500N	0.0 - 0.5	—	430E, 540N	0.0 - 0.5	0.1%
370E, 500N	0.5 - 1.0	—	430E, 540N	0.5 - 1.0	0.2%
370E, 520N	0.0 - 0.5	—	430E, 560N	0.0 - 0.5	0.4%
370E, 520N	0.5 - 1.0	0.2%	430E, 560N	0.5 - 1.0	0.1%
430E, 580N	0.0 - 0.5	0.2%	450E, 520N	0.5 - 1.0	—
430E, 580N	0.5 - 1.0	—	450E, 540N	0.0 - 0.5	—
445E, 480N	0.0 - 0.5	1.0%	450E, 540N	0.5 - 1.0	—
445E, 480N	0.5 - 1.0	1.0%	450E, 560N	0.0 - 0.5	—
450E, 500N	0.0 - 0.5	—	450E, 560N	0.5 - 1.0	—
450E, 500N	0.5 - 1.0	0.1%	450E, 580N	0.0 - 0.5	0.1%
450E, 520N	0.0 - 0.5	—	450E, 580N	0.5 - 1.0	0.1%

TABLE 1 (Continued)
SUMMARY SOIL ANALYTICAL RESULTS
ASBESTOS (%)
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

SAMPLE LOCATION	DEPTH (ft bgs)	RESULTS	SAMPLE LOCATION	DEPTH (ft bgs)	RESULTS
EXCAVATION AND TRENCHING SAMPLES					
S1	2	ND	S10	2.0	ND
S2	2	ND	S11	2.0	5%
S3	2	3%	S12	2.0	5%
S4	2	ND	S13	2	5%
S5	2	ND	S14	1	5%
S6	2	5%	S15	2	5%
S7	2	ND	S16	2	5%
S8	2	ND	S17	2	5%
S9	1	ND	S18	2	5%
ADDITIONAL SOIL INVESTIGATION SAMPLES					
P-254A	1.5	1%	P-259	1.25	ND
P-256	8.0	ND	P-270	2.75	ND
P-258	3.0	ND			

— = Non-Detectable

Analyses performed by polarized light microscope.

TABLE 2
SUMMARY SOIL ANALYTICAL RESULTS
SELECTED METALS
DETECTIONS ONLY (mg/kg)
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

LOCATION	DEPTH (ft)	DATE	ARSENIC	LEAD
P-254A	1.50	05/06/91	108	477
P-254A	10.50	05/06/91	—	9
P-255	6.50	05/07/91	—	10
P-256	8.00	05/07/91	—	27
P-257	1.75	05/07/91	20	167
P-258	3.00	05/08/91	36	177
P-258	5.75	05/08/91	5	8
P-259	9.50	05/08/91	—	13
P-259	11.25	05/08/91	—	9
P-260	5.50	05/09/91	87	224
P-260	7.50	05/09/91	12	5
P-261	3.25	05/09/91	—	15
P-261	16.00	05/09/91	5	15

— = Non Detected

TABLE 3
SUMMARY SOIL ANALYTICAL RESULTS
HYDROCARBONS
DETECTIONS ONLY (mg/kg)
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

LOCATION	DEPTH (ft)	DATE	TPH/DIESEL
MW-42	4.00	05/23/91	—
MW-43	19.00	05/23/91	—
P-254A	1.50	05/06/91	20.0
P-254A	10.50	05/06/91	—
P-255	6.50	05/07/91	—
P-256	8.00	05/07/91	—
P-257	1.75	05/07/91	22.0
P-258	3.00	05/08/91	—
P-258	5.75	05/08/91	—
P-259	9.50	05/08/91	440.0
P-259	11.25	05/08/91	—
P-260	5.50	05/09/91	—
P-260	7.50	05/09/91	—
P-261	3.25	05/09/91	290.0
P-261	16.00	05/09/91	130.00
P-262	3.75	05/10/91	73.00
P-262	5.75	05/06/91	380.00
P-262	15.00	05/10/91	17.0
P-264	7.75	05/10/91	—
P-266	6.50	05/13/91	94.0
P-267	12.50	05/13/91	7100.0
P-267	15.0	05/13/91	2000.0
P-268	12.25	05/13/91	8.8
P-269	13.00	05/14/91	—

TABLE 3 (Continued)
SUMMARY SOIL ANALYTICAL RESULTS
HYDROCARBONS
DETECTIONS ONLY (mg/kg)
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

LOCATION	DEPTH (ft)	DATE	TPH/DIESEL
P-270	3.50	05/14/91	—
P-270	7.25	05/14/91	—
P-271	3.25	05/14/91	—
P-271	6.50	05/14/91	—
P-280A	2.00	05/15/91	1000.00
P-280A	3.00	05/15/91	—
P-285	4.20	05/17/91	840.0
P-285	7.00	05/17/91	—
P-286	2.75	05/20/91	800.0
P-268	5.00	05/20/91	200.0
P-287A	1.50	05/15/91	—
P-287A	3.00	05/15/91	—
P-288A	2.00	05/15/91	—
P-288A	4.50	05/15/91	—
P-291	10.00	05/23/91	18.0
SB-23	19.00	05/24/91	—
SB-23	24.00	05/24/91	—
SB-23	29.00	05/24/91	—
SB-24	10.00	05/24/91	14.0
SB-24	20.00	05/24/91	—
SB-24	25.00	05/24/91	—

— = Non Detected

TABLE 4
SUMMARY SOIL ANALYTICAL RESULTS
PURGEABLE AROMATICS
DETECTIONS ONLY (mg/kg)
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

LOCATION	DEPTH	DATE	BENZENE	ETHYLBENZENE	TOLUENE	XYLENES
MW-43	14.0	05/23/91	—	—	—	—
MW-43	19.0	05/23/91	—	—	—	—
P-266	6.5	05/13/91	—	—	—	—
P-267	12.5	05/13/91	—	—	17.0	14.0
SB-23	19.0	05/24/91	—	—	—	—

— = Non-Detect.

TABLE 5
SLAG AND SOIL ANALYTICAL RESULTS
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Testpit	SURFACE SLAG/GRAVEL INTERVAL[1]							SOIL TRANSITIONAL INTERVAL							SOIL LOWER INTERVAL		
	Sieve Analysis (Dry)		Particle Size, mm	T T L C (mg/kg)				T T L C (mg/kg)					S T L C (mg/l)		TTLC (mg/kg)		
	% <0.074 mm	% <0.149 mm	Range of Analyzed Fraction	As	Pb	Cu	Zn	Depth (ft. bgs)	As	Pb	Cu	Zn	As	Pb	Depth (ft. bgs)	As	Pb
P-272	1.4	2.8	4.76 - 9.51	65.2	173	321	685	2.5	4.0/<5.0[2]	98/71[2]	30/31[2]	80/81[2]	<1.0	3.1	--	--	--
P-273	3.5	6.7	<0.074	38.0	448	323	725	0.5	4.2	18	29	56	<1.0	<0.1	--	--	--
			0.841 - 2.00	50.4	725	695	2190										
P-274	4.0	8.6	--	--	--	--	--	0.75	24.9/27[2]	730/790[2]	148/135[2]	97/291[2]	<1.0	32.0	2.0	3.1	40
P-275	4.0	7.5	<0.074	184	1050	1590	2960	0.9	16.5	59	47	71	<1.0	1.1	1.9	2.6	17
			0.149 - 0.250	198	1160	1610	3550										
			2.00 - 4.76	75.6	1080	1230	4240										
P-276	3.5	5.6	--	--	--	--	--	1.1	230/287[2]	11/9[2]	22/23[2]	36/34[2]	10.1	<0.1	2.1	4.1	18
P-277	3.8	7.2	19.00 - 25.40	42.9	117	545	132	0.5	1.9	11	18	32	<1.0	<0.1	--	--	--
P-278	2.4	4.3	<0.074	439	1900	2670	3900	0.9	635/484[2]	810/323[2]	149/101[2]	105/93[2]	21.1	30.0	1.9	34	12
			0.250 - 0.420	193	1670	2270	4710										
P-279	2.6	4.7	0.841 - 2.00	58.6	990	1860	3190	0.5	1.9	12	22	38	<1.0	<0.1	--	--	--
P-280	1.2	2.4	<0.074	345	2250	3790	7250	1.0	30.1/20[2]	414/31[2]	107/37[2]	148/58[2]	<1.0	13.0	3.0	5.2	18
			0.149 - 0.250	251	2100	3030	7700										
			9.51 - 12.70	41.1	307	430	855										

TABLE 5 (Continued)
SLAG AND SOIL ANALYTICAL RESULTS
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Testpit	SURFACE SLAG/GRAVEL INTERVAL[1]							SOIL TRANSITIONAL INTERVAL							SOIL LOWER INTERVAL		
	Sieve Analysis (Dry)		Particle Size, mm	T T L C (mg/kg)				T T L C (mg/kg)					S T L C (mg/l)		TTLC (mg/kg)		
	% < 0.074 mm	% < 0.149 mm	Range of Analyzed Fraction	As	Pb	Cu	Zn	Depth (ft. bgs)	As	Pb	Cu	Zn	As	Pb	Depth (ft. bgs)	As	Pb
P-281	1.2	2.4	<0.074	65.1	1730	890	1690	0.9	2.7	14	24	45	<1.0	<0.1	–	–	–
			0.420 - 0.841	88.3	1210	660	2780										
			4.76 - 9.51	84.7	261	865	940										
P-282	5.6	11.7	–	–	–	–	–	0.9	7.6	64	29	60	<1.0	1.3	–	–	–
P-283	4.8	9.7	–	–	–	–	–	2.0	6.3	46	28	57	<1.0	<0.1	–	–	–
P-284	7.6	14.4	–					1.0	2.6	17	22	38	<1.0	<0.1	–	–	–
P-285	4.2	8.2	–	–	–	–	–	1.75	15.2	18	30	58	<1.0	<0.1	2.75	2.2	14
P-286	1.8	3.5	–	–	–	–	–	2.75	4.0	15	33	52	<1.0	<0.1	–	–	–
P-287	3.3	6.8	–	–	–	–	–	1.5	2.5	13	27	44	<1.0	<0.1	3.0	3.7	<0.1
P-288	4.2	8.7	–	–	–	–	–	2.0	3.1	15	25	39	<1.0	<0.1	–	–	–
P-289	5.0	9.1	9.51 - 12.70	20.4	257	437	925	1.5	3.0	15	28	46	<1.0	<0.1	–	–	–
P-290	2.2	4.4	–	–	–	–	–	0.5	290<5.0[2]	1,610/29[2]	2,500/35[2]	5,250/56[2]	<1.0	<0.1	1.5	6.1	62

1. Samples containing greater than 6mm size particles contain non-slag material due to the difficulty of separating by magnet the weakly magnetic slag particles. Samples with particle sizes less than 6mm are interpreted to be all slag.

2. These are results from a reanalysis of duplicate soil samples inspected for, and purged of, slag particles by visual observation and magnetic separation.

TABLE 6
GROUNDWATER ELEVATION DATA, 1988-1991
(Elevations in feet from mean sea level datum)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

DATE	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-11	MW-12	MW-13
02/19/88	0	-0.85	-0.61	-3.50	-3.37	-3.64	-5.73	-5.40	—	—	—
03/02/88	-0.02	-0.92	-0.62	-3.49	-3.44	-3.70	-4.83	-4.21	—	—	—
04/14-15-16/88	0.04	-1.22	-1.26	-3.71	-3.70	-3.96	-5.07	-4.47	—	—	—
07/15/88	-0.32	-2.24	-2.39	-4.50	-4.62	-4.85	-5.86	-5.24	—	—	—
08/19/88	-0.53	*	-2.97	-4.94	-5.05	-5.28	-6.25	-5.64	—	—	—
01/06/89	-1.92	*	-2.50	-5.42	-5.44	-5.68	-6.76	-6.16	—	—	—
10/09/89	-1.52	-2.83	-2.68	-5.43	-5.46	-5.72	-6.85	-6.21	-4.99	-5.63	-5.48
02/21/90	-1.29	-1.22	-0.24	-4.12	-4.20	-4.50	-5.83	-5.10	-3.48	-4.47	-4.21
06/15/90	-0.86	-1.99	-2.01	-4.66	-4.61	-4.90	-6.07	-5.44	-4.20	-4.93	-4.73
09/20/90	-1.89	-3.76	-4.05	-6.14	-6.15	-6.40	-7.47	-6.85	-5.74	-6.38	-6.18
02/05/91	-3.18	-3.85	-3.81	-6.60	-6.57	-6.84	-7.94	-7.37	-6.04	-6.82	-6.69
04/22/91	-2.05	-2.37	-2.22	-5.12	-5.07	-5.37	-6.59	-5.93	-4.64	-5.38	-5.18
07/30/91	-2.40	-3.98	-4.14	-6.43	-6.47	-6.73	-7.79	-7.17	-6.01	-6.65	-6.47

DATE	MW-14	MW-15	MW-16	MW-17	MW-18	MW-19	MW-20	MW-21	MW-22	MW-23	MW-24
10/09/89	-5.55	-5.56	-5.56	-6.03	-6.09	-6.77	-6.85	-6.43	-6.41	-6.10	-6.10
02/21/90	-4.31	-4.29	-4.29	-4.82	-4.95	-5.82	-5.91	-5.35	-5.33	-4.96	-4.94
06/15/90	-4.80	-4.79	-4.79	-5.28	-5.36	-6.05	-6.12	-5.64	-5.62	-5.30	-5.27
09/20/90	-6.26	-6.26	-6.25	-6.69	-6.76	-7.37	-7.45	-7.07	-7.04	-6.77	-6.75
02/05/91	-6.76	-6.71	-6.71	-7.23	-7.29	-7.97	-8.03	-7.55	-7.53	-7.22	-7.18
04/22/91	-5.27	-5.22	-5.23	-5.77	-5.85	-6.57	-6.65	-6.13	-6.13	-5.80	-5.77
07/30/91	-6.53	-6.57	-6.55	-7.00	-7.06	-7.70	-7.76	-7.38	-7.35	-7.09	-7.07

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TABLE 6 (Continued)
GROUNDWATER ELEVATION DATA, 1988-1991
(Elevations in feet from mean sea level datum)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

DATE	MW-25	MW-26	MW-27	MW-28	MW-29	MW-30	MW-31	MW-32	MW-33	MW-34	MW-35
10/09/89	-7.47	-7.46	-7.46								
02/21/90	-6.55	-6.55	-6.54	-5.35	-5.01	-5.07	—	—	—	—	—
06/15/90	-6.70	-6.70	-6.69	-5.66	-5.34	-5.37	-5.51	-6.04	-4.21	—	—
09/20/90	-8.05	-8.05	-8.04	-7.04	-6.73	-6.76	-6.88	-7.34	-5.75	—	—
02/05/91	-8.55	-8.55	-8.53	-7.59	-7.31	-7.40	-7.48	-7.93	-7.04	—	—
04/22/91	-7.26	-7.27	-7.25	-6.16	-5.86	-5.90	-6.02	-6.57	-4.63	—	—
07/30/91	-8.39	-8.38	-8.37	-7.32	-7.04	-7.07	-7.19	-7.66	-6.01	-8.34	-8.30

DATE	MW-39	MW-40	MW-41	MW-42	MW-43
07/30/91	-13.73	-7.83	-6.66	-5.07	-4.24

* Lock-on well cover was vandalized, rendering well inaccessible.

TABLE 7
CHANGES IN WATER LEVELS
BETWEEN 1988 AND 1991
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

	2/88 - 2/91	2/90 - 2/91
MW-1	-3.18	-1.89
MW-2	-3.00	-2.63
MW-3	-3.20	3.57
MW-4	-3.10	-2.48
MW-5	-3.20	-2.37
MW-6	-3.20	-2.34
MW-7	-2.21	-2.11
MW-8	-1.97	-2.27
MW-11	—	-2.56
MW-12	—	-2.35
MW-13	—	-2.48
MW-14	—	-2.45
MW-15	—	-2.42
MW-16	—	-2.42
MW-17	—	-2.41
MW-18	—	-2.34
MW-19	—	-2.15
MW-20	—	-2.12
MW-21	—	-2.20
MW-22	—	-2.20
MW-23	—	-2.26
MW-24	—	-2.24
MW-25	—	-2.00
MW-26	—	-2.00
MW-27	—	-1.99
MW-28	—	-2.24
MW-29	—	-2.30
MW-30	—	-2.33
Average Change	-2.48	-2.25

TABLE 8
SUMMARY GROUNDWATER ANALYTICAL RESULTS
SELECTED METALS - DETECTIONS ONLY (μg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

Monitoring Well	Date Sampled	As	Cr	Ni*	Pb
MCL		50	50	NE	50
Background Concentration		0 - 20	1 - 20	1 - 12	<1 - 9
MW-01	03/03/88	4.0	--	--	--
	09/20/89	--	--	--	--
	05/10/90	9.0	--	--	--
	09/05/90	--	--	--	--
	01/21/91	--	--	--	--
	04/22/91	--	5.0	130.0	--
MW-02	03/03/88	3.0	--	--	--
	09/20/89	--	--	--	--
	05/17/90	1.0	--	20.0	--
	09/11/90	--	--	--	--
	01/22/91	--	--	--	--
	04/22/91	--	5.7	140.0	--
MW-03	03/03/88	4.0	--	--	--
	09/20/89	--	--	--	16.0
	02/13/90	NA	NA	NA	20.0
	05/10/90	9.0	--	--	20.0
	09/05/90	--	--	--	--
	01/22/91	--	--	--	--
	04/23/91	--	1.5	--	--
MW-04	03/03/88	6.0	--	140.0	--
	09/20/89	--	--	34.0	12.0
	02/15/90	NA	NA	NA	10.0
	05/23/90	--	4.5	99.0	--
	09/18/90	--	--	71.0	--
	02/05/91	--	33.0	200.0	--
	05/01/91	6.1	--	11.0	--

TABLE 8 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
SELECTED METALS - DETECTIONS ONLY (μg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

Monitoring Well	Date Sampled	As	Cr	Ni*	Pb
MCL		50	50	NE	50
Background Concentration		0 - 20	1 - 20	1 - 12	<1 - 9
MW-05	03/04/88	--	10.0	--	--
	09/20/89	9.3	--	159.0	--
	05/17/90	2.0	--	70.0	--
	09/12/90	--	14.0	--	--
	01/22/91	--	11.0	100.0	--
	04/23/91	--	7.2	81.0	--
MW-06	03/04/88	5.0	--	--	--
	09/20/89	--	7.1	39.0	--
	05/17/90	2.0	--	100.0	--
	09/11/90	--	21.0	42.0	--
	01/24/91	7.0	15.0	--	--
	04/23/91	5.8	5.4	40.0	--
MW-07	03/04/88	4.0	10.0	50.0	--
	09/15/89	--	5.0	405.0	--
	05/23/90	--	111.0	215.0	10.0
	09/07/90	--	15.0	250.0	--
	01/30/91	7.0	200.0	200.0	--
	04/26/91	--	18.0	130.0	--
MW-08	03/03/88	--	--	--	--
	09/20/89	--	--	--	--
	02/13/90	NA	NA	NA	30.0
	05/23/90	--	--	12.0	24.0
	09/13/90	--	--	--	--
	01/30/91	6.0	--	--	70.0
	04/26/91	--	8.8	29.0	--

TABLE 8 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
SELECTED METALS - DETECTIONS ONLY (μg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

Monitoring Well	Date Sampled	As	Cr	Ni*	Pb
MCL		50	50	NE	50
Background Concentration		0 - 20	1 - 20	1 - 12	<1 - 9
MW-11	09/06/89	9.7	27.0	160.0	57.0
	02/15/90	NA	NA	NA	20.0
	05/18/90	--	47.6	76.0	--
	09/17/90	--	47.0	55.0	--
	01/30/91	--	200.0	--	--
	04/26/91	--	38.0	32.0	--
MW-12	09/11/89	28.0	18.0	15.0	--
	02/15/90	NA	NA	NA	--
	05/22/90	--	10.0	51.0	15.0
	09/18/90	--	10.0	71.0	--
	02/04/91	--	50.0	200.0	--
	05/01/91	--	6.6	78.0	--
MW-13	09/13/89	18.0	--	14.0	--
	02/15/90	NA	NA	NA	--
	05/25/90	30.0	--	10.0	--
	09/18/90	36.0	--	--	--
	02/05/91	20.0	--	100.0	--
	04/30/91	33.0	--	7.2	--
MW-14	09/13/89	--	--	169.0	--
	02/15/90	NA	NA	NA	--
	05/22/90	--	16.0	174.0	--
	09/18/90	--	13.0	160.0	--
	02/04/91	--	21.0	300.0	--
	05/01/91	--	37.0	98.0	--

TABLE 8 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
SELECTED METALS - DETECTIONS ONLY (µg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

Monitoring Well	Date Sampled	As	Cr	Ni*	Pb
MCL		50	50	NE	50
Background Concentration		0 - 20	1 - 20	1 - 12	<1 - 9
MW-15	09/07/89	6.0	--	--	--
	02/07/90	NA	NA	NA	30.0
	05/16/90	4.0	30.0	70.0	--
	09/14/90	5.0	--	52.0	--
	01/24/91	--	12.0	--	--
	04/25/91	--	11.0	51.0	--
MW-16	09/07/89	6.0	--	--	--
	02/07/90	NA	NA	NA	30.0
	05/16/90	2.0	--	--	--
	09/14/90	--	10.0	--	--
	01/24/91	7.0	11.0	--	--
	04/25/91	--	5.7	20.0	--
MW-17	09/21/89	--	--	--	--
	02/07/90	NA	NA	NA	30.0
	05/18/90	--	7.2	67.0	12.0
	09/13/90	--	--	50.0	--
	01/25/91	7.0	9.0	200.0	--
	04/29/91	--	6.9	170.0	--
MW-18	09/21/89	--	--	10.0	--
	02/07/90	NA	NA	NA	40.0
	05/18/90	--	5.5	13.0	21.0
	09/13/90	--	--	--	--
	01/25/91	6.0	7.0	--	--
	04/29/91	--	6.5	24.0	--

TABLE 8 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
SELECTED METALS - DETECTIONS ONLY (μg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

Monitoring Well	Date Sampled	As	Cr	Ni*	Pb
MCL		50	50	NE	50
Background Concentration		0 - 20	1 - 20	1 - 12	<1 - 9
MW-19	09/14/89	--	--	14.0	--
	02/13/90	NA	NA	NA	20.0
	05/14/90	8.0	--	60.0	50.0
	09/07/90	--	--	45.0	--
	01/24/91	10.0	--	--	--
	04/29/91	--	16.0	69.0	--
MW-20	09/14/89	--	--	--	--
	02/13/90	NA	NA	NA	--
	05/14/90	8.0	--	--	40.0
	09/07/90	--	--	--	--
	01/24/91	7.0	--	--	--
	04/29/91	--	15.0	5.3	--
MW-21	09/08/89	8.4	--	15.0	--
	05/15/90	6.0	--	380.0	40.0
	09/07/90	--	29.0	300.0	--
	01/23/91	5.0	7.0	300.0	--
	04/25/91	--	8.4	310.0	--
MW-22	09/08/89	24.0	--	17.0	--
	05/15/90	9.0	--	--	20.0
	09/07/90	--	--	--	--
	01/23/91	--	--	--	--
	04/25/91	--	6.9	9.6	--
MW-23	09/08/89	9.7	--	--	--
	05/15/90	3.0	--	450.0	30.0
	09/06/90	--	--	250.0	--
	01/23/91	--	--	400.0	--
	04/23/91	--	6.5	360.0	--

TABLE 8 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
SELECTED METALS - DETECTIONS ONLY (μg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

Monitoring Well	Date Sampled	As	Cr	Ni*	Pb
MCL		50	50	NE	50
Background Concentration		0 - 20	1 - 20	1 - 12	<1 - 9
MW-24	09/08/89	15.0	--	--	--
	05/15/90	5.0	--	420.0	30.0
	09/06/90	--	--	110.0	--
	01/23/91	--	--	100.0	2.0
	04/24/91	--	2.9	240.0	--
MW-25	09/11/89	11.0	--	--	--
	05/16/90	3.0	--	200.0	--
	09/12/90	--	11.0	130.0	--
	01/29/91	8.0	10.0	300.0	--
	04/24/91	--	--	240.0	--
MW-26	09/11/89	11.0	--	--	--
	05/16/90	--	--	200.0	--
	09/12/90	--	--	260.0	--
	01/29/91	--	--	300.0	--
	04/24/91	--	8.0	240.0	--
MW-27	09/15/89	--	19.0	--	--
	05/21/90	--	--	67.0	23.3
	09/17/90	--	--	49.0	--
	01/29/91	--	8.0	--	--
	04/24/91	--	6.1	38.0	--
MW-28	02/15/90	NA	NA	NA	--
	05/25/90	--	4.4	26.0	16.0
	09/19/90	--	49.0	52.0	--
	02/01/91	--	10.0	--	1.0
	04/30/91	--	6.0	32.0	--

TABLE 8 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
SELECTED METALS - DETECTIONS ONLY (μg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

Monitoring Well	Date Sampled	As	Cr	Ni*	Pb
MCL		50	50	NE	50
Background Concentration		0 - 20	1 - 20	1 - 12	<1 - 9
MW-29	02/15/90	NA	NA	NA	20.0
	05/25/90	--	--	15.0	--
	09/06/90	--	--	--	--
	02/01/91	--	--	--	10.0
	04/30/91	--	3.0	58.0	--
MW-30	02/15/90	NA	NA	NA	20.0
	05/24/90	5.0	--	174.0	63.0
	09/05/90	--	--	190.0	--
	02/04/91	--	--	200.0	2.0
	04/30/91	--	7.9	130.0	--
MW-31	05/24/90	9.0	--	201.0	30.0
	09/19/90	--	--	200.0	--
	02/01/91	--	--	200.0	1.0
	05/01/91	--	13.0	73.0	--
MW-32	05/24/90	--	7.4	169.0	10.0
	09/19/90	--	--	120.0	--
	02/01/91	--	40.0	200.0	4.0
	05/01/91	--	12.0	65.0	--
MW-33	05/18/90	--	--	17.0	35.0
	09/14/90	--	--	--	--
	01/30/91	8.0	200.0	--	--
	04/30/91	--	3.5	56.0	--
MW-34	07/02/91	--	7.0	300.0	--
MW-35	07/02/91	--	5.0	--	--
MW-39	06/28/91	10.0	17.0	--	1.0
MW-40	06/28/91	5.0	4.0	--	--
MW-41	06/28/91	15.0	5.0	--	--
MW-42	06/28/91	8.0	--	200.0	1.0

TABLE 8 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
SELECTED METALS - DETECTIONS ONLY (μg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

Monitoring Well	Date Sampled	As	Cr	Ni*	Pb
MCL		50	50	NE	50
Background Concentration		0 - 20	1 - 20	1 - 12	<1 - 9
MW-43	06/28/91	10.0	--	200.0	--

* Although no MCL exists for Nickel, the DHS-Applied Action Level (AAL) which is solely health risk based, is 400 μg/l.
MCL Maximum Contaminant Level for drinking water, EPA or DHS, whichever is more stringent.
NE None exists.
-- Not detected.
NA Not analyzed.
Background Concentration - Values were obtained from Johnson, 1985 (see references).

For duplicate sample analyses, the highest measured value is recorded.

TABLE 9
SUMMARY GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTIONS ONLY ($\mu g/l$)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

MONITORING WELL	DATE SAMPLED	B	T	X	E	1,1,1 -TCA	1,1,2 -TCA	1,1- DCA	1,1- DCE	1,2- DCA	CHLORO FORM	PCE	TCE	CCL_4	TPH	TPH/ Gas
		MCL/AL														
		1	100*	1,750	680	200	32	5*	6	0.5	100	5	5	0.5	NE	NE
MW-01	03/03/88	–	–	–	–	–	–	–	–	–	0.8**	–	–	–	–	–
	09/20/89	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	05/10/90	–	–	–	–	–	–	–	–	–	–	–	–	–	N/A	N/A
	09/05/90	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
	01/21/91	–	–	–	–	–	–	–	–	–	0.80	–	–	–	N/A	N/A
MW-02	03/03/88	–	–	–	–	–	–	–	–	–	0.6**	–	–	–	280**	–
	09/20/89	–	1.4	–	–	–	–	–	–	–	–	–	–	–	–	50*
	05/17/90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	09/11/90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	01/22/91	–	–	–	–	–	–	–	–	–	–	–	–	–	N/A	N/A
	04/22/91	–	–	–	–	–	–	–	–	–	–	–	–	–	N/A	N/A
MW-03	03/03/88	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	09/20/89	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	05/10/90	–	–	–	–	–	–	–	–	–	–	–	–	–	N/A	N/A
	09/05/90	–	–	–	–	–	–	–	–	–	–	–	–	–	N/A	N/A
	01/22/91	–	–	–	–	–	–	–	–	–	–	–	–	–	N/A	N/A
MW-04	03/03/88	11	4.5	6	1.5	22	–	12	130	42	–	–	–	–	1100	300
	09/20/89	210	–	–	–	–	–	7.1	–	120	–	–	–	–	–	3000
	02/15/90	190	3.5	7.5	2.1	5.3	–	12	250	46	–	–	5.7	–	N/A	N/A
	05/23/90	130	4.9	2.1	6.3	4.1	–	5.8	5.5	45	–	–	4.9	–	–	650
	09/18/90	98	4.1	2.7	4.3	2.4	–	6	30	38	–	–	4.5	–	–	–
	02/05/91	17	–	–	–	1.2	–	6	45	16	–	–	4.2	–	N/A	N/A
	05/01/91	580	–	24	12	–	–	11	15	93	–	–	.89	–	N/A	N/A

SAC21.006

TABLE 9 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTIONS ONLY (μg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

MONITORING WELL	DATE SAMPLED	B	T	X	E	1,1,1 -TCA	1,1,2 -TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLORO FORM	PCE	TCE	CCL_4	TPH	TPH/ Gas
		MCL/AL														
		1	100*	1.750	680	200	32	5*	6	0.5	100	5	5	0.5	NE	NE
MW-05	03/04/88	–	–	–	–	–	–	–	–	–	4.9	–	–	–	–	–
	09/20/89	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60**
	05/17/90	–	–	–	–	–	–	–	–	–	2.6	–	–	–	–	–
	09/12/90	–	–	–	–	–	–	–	–	–	2.3	–	–	–	–	–
MW-06	03/04/88	–	–	–	–	–	–	–	–	–	0.6**	–	–	–	–	–
	09/20/89	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	05/17/90	–	–	–	–	–	–	–	–	–	1.5	–	–	–	N/A	N/A
	09/11/90	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–
MW-07	03/04/88	–	–	–	–	25	–	15	17	1.6	1.9	–	1	–	–	–
	09/15/89	–	–	–	–	26	–	15	0.5**	3.1	1.1	–	1.1	–	–	50**
	02/07/90	–	–	–	–	11	–	9.9	58	–	2.6	–	0.6	–	N/A	N/A
	05/17/90	–	–	–	–	9.7	–	9.2	8.1	–	3	–	–	–	–	–
	09/07/90	–	–	–	–	6.4	–	6.1	19	–	2.5	–	–	–	–	–
	01/30/91	N/A	N/A	N/A	N/A	5.1	–	4.3	15	–	2.6	–	–	–	N/A	N/A
	04/26/91	N/A	N/A	N/A	N/A	4.6	–	4.5	11	–	3.0	–	–	–	N/A	N/A
MW-08	03/03/88	–	–	–	–	–	–	0.9	–	–	–	0.8**	–	–	–	–
	09/20/89	–	2.5	–	–	–	–	–	–	–	–	1.5	–	–	–	–
	05/23/90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	09/13/90	–	–	–	–	0.6	–	–	3.8	–	–	–	–	–	–	–
	01/30/91	N/A	N/A	N/A	N/A	–	–	–	1.8	–	–	–	–	–	N/A	N/A
	04/26/91	N/A	N/A	N/A	N/A	–	–	–	1.8	–	–	3.2	–	–	N/A	N/A

TABLE 9 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTIONS ONLY (μg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

MONITORING WELL	DATE SAMPLED	B	T	X	E	1,1,1 -TCA	1,1,2 -TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLORO FORM	PCE	TCE	CCL_4	TPH	TPH/ Gas
		MCL/AL														
		1	100*	1.750	680	200	32	5*	6	0.5	100	5	5	0.5	NE	NE
MW-11	09/06/89	–	6	–	–	–	–	0.8	–	–	5.1	–	1.7	–	600	120
	02/15/90	–	–	–	–	–	–	–	8.3	–	0.6	–	0.5	–	N/A	N/A
	05/18/90	–	–	–	–	–	–	3.2	–	–	–	0.7	4.2	–	–	–
	09/17/90	–	–	–	–	1.7	–	6.2	18	–	–	–	2.4	–	–	–
	01/30/91	N/A	N/A	N/A	N/A	2.8	–	16	46	–	–	–	2.5	–	N/A	N/A
	04/26/91	N/A	N/A	N/A	N/A	4.5	–	19	62	–	–	–	3.5	–	N/A	N/A
MW-12	09/11/89	–	2.2	–	–	–	–	1.3	–	–	6.4	–	4	–	–	70**
	10/13/89	0.8**	–	–	–	–	–	4.9	26.3	–	4.5	–	5.7	–	N/A	N/A
	02/15/90	–	–	–	–	–	–	9.6	62	–	1.4	–	9	–	N/A	N/A
	05/22/90	–	–	–	–	–	–	9.2	1.4	–	0.6	–	9.4	–	–	–
	09/18/90	–	–	–	–	0.88	–	10	24	–	–	–	12	–	–	–
	02/04/91	–	–	–	–	–	–	15	47	–	–	–	14	–	N/A	N/A
	05/01/91	N/A	N/A	N/A	N/A	–	–	12	52	–	–	–	15	–	N/A	N/A
MW-13	09/13/89	5700	343	147	–	–	0.8	13.2	–	360	–	–	0.6	–	3100	51000
	11/02/89	6700	210	88	50	–	–	20	24	270	–	–	–	–	N/A	N/A
	02/15/90	10500	400	1600	150	–	–	40	55	200	–	–	–	–	N/A	N/A
	05/25/90	12000	250	530	1200	–	–	35	1.8	250	–	–	–	–	2400	46000
	09/18/90	7300	310	620	410	–	–	27	15	210	–	–	–	–	–	12000
	02/05/91	10,000	390	600	–	0.6	–	36	25	96	–	–	–	–	N/A	N/A
	04/30/91	7,900	260	520	340	0.5	–	17	14	120	–	–	–	–	N/A	N/A

TABLE 9 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTIONS ONLY ($\mu g/l$)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

MONITORING WELL	DATE SAMPLED	B	T	X	E	1,1,1-TCA	1,1,2-TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLOROFORM	PCE	TCE	CCL_4	TPH	TPH/Gas
		MCL/AL														
		1	100*	1.750	680	200	32	5*	6	0.5	100	5	5	0.5	NE	NE
MW-14	09/13/89	–	12.3	–	–	22	7.1	9.4	15.1	3.7	2.5	–	5.6	–	–	100
	11/02/89	–	–	–	–	20	6.3	9.3	75	7.7	2.5	–	4.7	–	N/A	N/A
	02/15/90	3.6	–	0.6	–	8.9	1.1	9.6	380	1	–	–	8	–	N/A	N/A
	05/22/90	2.2	–	–	–	4.1	–	5.8	11	1.4	–	–	5.9	–	–	–
	09/18/90	–	–	–	–	2.3	–	5	47	–	–	–	5.7	–	–	–
	02/04/91	–	–	–	–	1.3	–	4.4	47	–	–	–	6.2	–	N/A	N/A
	05/01/91	–	–	–	–	0.88	–	3.1	18	–	–	–	4.9	–	N/A	N/A
MW-15	09/07/89	–	–	–	–	–	–	–	–	–	–	2.2	–	–	–	–
	02/07/90	–	–	–	–	0.5	–	–	5.8	–	–	2.8	–	–	N/A	N/A
	05/16/90	–	–	–	–	–	–	–	–	–	–	3.5	–	–	N/A	N/A
	09/14/90	–	–	–	–	1.1	–	–	0.58	–	–	6.2	–	–	–	–
	01/24/91	N/A	N/A	N/A	N/A	0.7	–	–	1.2	–	–	–	6.8	–	N/A	N/A
	04/25/91	N/A	N/A	N/A	N/A	0.53	–	–	0.82	–	–	–	6.7	–	N/A	N/A
MW-16	09/07/89	–	3.9	–	–	0.8**	–	0.7**	–	–	0.5	–	–	–	–	–
	02/07/90	–	–	–	–	2	–	1.8	29	–	–	–	–	–	N/A	N/A
	05/16/90	–	–	–	–	–	–	–	–	–	–	–	–	–	N/A	N/A
	09/14/90	–	–	–	–	1.3	–	–	2.3	–	–	–	–	–	–	–
	01/24/91	N/A	N/A	N/A	N/A	–	–	–	2.6	–	–	–	–	–	N/A	N/A
	04/25/91	N/A	N/A	N/A	N/A	0.83	–	–	2.8	–	–	–	–	–	N/A	N/A

TABLE 9 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTIONS ONLY (μg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

MONITORING WELL	DATE SAMPLED	B	T	X	E	1,1,1 -TCA	1,1,2 -TCA	1,1- DCA	1,1- DCE	1,2- DCA	CHLORO FORM	PCE	TCE	CCL_4	TPH	TPH/ Gas
		MCL/AL														
		1	100*	1.750	680	200	32	5*	6	0.5	100	5	5	0.5	NE	NE
MW-17	09/21/89	–	1.3	–	–	1.1	–	0.5**	–	–	2.6	–	0.7**	–	–	–
	02/07/90	–	–	–	–	0.8	–	0.6	36	–	–	–	0.5	–	N/A	N/A
	05/18/90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	09/13/90	–	–	–	–	–	–	–	4.0	–	–	–	–	–	–	–
	01/25/91	–	–	–	–	–	–	–	3.0	–	–	–	–	–	N/A	N/A
	04/29/91	–	–	–	–	–	–	–	3.8	–	–	–	–	–	N/A	N/A
MW-18	09/21/89	–	1.3	–	–	1.9	0.8**	3.4	0.5**	–	1.5	–	9.4	–	–	50**
	11/02/89	–	–	–	–	6.9	1	7.8	92	–	0.5**	–	13	–	N/A	N/A
	02/07/90	–	–	–	–	4	–	4.8	230	–	–	–	8.1	–	N/A	N/A
	05/18/90	–	–	–	–	2.4	–	2.8	3.2	–	–	1	10	–	–	–
	09/13/90	–	–	–	–	3.3	–	3.9	19	–	–	–	4.4	–	–	–
	01/25/91	–	–	–	–	0.90	–	1.4	22	–	–	–	2.9	–	N/A	N/A
	04/29/91	–	–	–	–	0.94	–	1.1	20	–	–	–	2.3	–	N/A	N/A
MW-19	09/14/89	–	–	–	–	–	–	–	–	–	0.9**	1	–	–	–	–
	05/18/90	–	–	–	–	–	–	–	–	–	–	1.4	–	–	N/A	N/A
	09/07/90	–	–	–	–	–	–	–	6.8	–	–	1.5	–	–	–	–
	01/24/91	N/A	N/A	N/A	N/A	–	–	–	5.9	–	–	–	1.7	–	N/A	N/A
	04/29/91	N/A	N/A	N/A	N/A	–	–	–	4.2	–	–	–	1.9	–	N/A	N/A

TABLE 9 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTIONS ONLY ($\mu g/l$)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

MONITORING WELL	DATE SAMPLED	B	T	X	E	1,1,1 -TCA	1,1,2 -TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLORO FORM	PCE	TCE	CCL_4	TPH	TPH/ Gas
		MCL/AL														
		1	100*	1,750	680	200	32	5*	6	0.5	100	5	5	0.5	NE	NE
MW-20	09/14/89	–	–	–	–	0.7	–	–	–	–	–	–	–	–	–	–
	05/14/90	–	–	–	–	1.4	–	0.9	–	–	–	–	–	–	N/A	N/A
	09/07/90	–	–	–	–	0.92	–	–	9.6	–	–	–	–	–	–	–
	01/24/91	N/A	N/A	N/A	N/A	–	–	–	9.8	–	–	–	–	–	N/A	N/A
	04/29/91	N/A	N/A	N/A	N/A	–	–	–	8.9	–	–	–	–	–	N/A	N/A
MW-21	09/08/89	–	–	–	–	–	–	–	–	–	1.6	–	–	–	–	–
	05/15/90	–	–	–	–	–	–	0.6	–	–	4.2	–	–	–	N/A	N/A
	09/07/90	–	–	–	–	–	–	–	2.1	–	1.9	–	–	–	–	–
	01/23/91	N/A	N/A	N/A	N/A	–	–	–	0.8	–	2.4	–	–	–	N/A	N/A
	04/25/91	N/A	N/A	N/A	N/A	–	–	–	4.7	–	2.5	–	–	–	N/A	N/A
MW-22	09/08/89	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–
	02/07/90	–	–	–	–	–	–	–	–	–	0.9	–	–	–	N/A	N/A
	05/15/90	–	–	–	–	–	–	–	–	–	5	–	–	–	N/A	N/A
	09/07/90	–	–	–	–	–	–	–	–	–	2.6	–	–	–	–	–
	01/23/91	N/A	N/A	N/A	N/A	–	–	–	–	–	5.2	–	–	–	N/A	N/A
	04/25/91	N/A	N/A	N/A	N/A	–	–	–	–	–	4.8	–	–	–	N/A	N/A
MW-23	09/08/89	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	05/15/90	–	–	–	–	–	–	1.3	–	–	10	–	–	–	N/A	N/A
	09/06/90	–	–	–	–	–	–	0.88	0.5	–	4.2	–	–	–	–	–
	04/23/91	N/A	N/A	N/A	N/A	–	–	–	0.67	–	3.0	–	–	–	N/A	N/A

TABLE 9 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTIONS ONLY (μg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

MONITORING WELL	DATE SAMPLED	B	T	X	E	1,1,1 -TCA	1,1,2 -TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLORO FORM	PCE	TCE	CCl_4	TPH	TPH/ Gas
		MCL/AL														
		1	100*	1,750	680	200	32	5*	6	0.5	100	5	5	0.5	NE	NE
MW-24	09/08/89	–	–	–	–	–	–	–	–	–	2.8	–	–	–	–	–
	05/15/90	–	–	–	–	–	–	–	–	–	11	–	–	–	N/A	N/A
	09/06/90	–	–	–	–	–	–	–	–	–	4.1	–	–	–	–	–
	09/06/90	–	–	–	–	–	–	–	–	–	4.1	–	–	–	–	–
MW-25	09/11/89	–	4.1	–	–	–	–	1	–	–	0.9**	–	–	–	–	–
	02/07/90	–	–	–	–	–	–	1.3	7.6	–	1.1	–	–	–	N/A	N/A
	05/16/90	–	–	–	–	–	–	1.3	–	–	1.1	–	–	–	–	–
	09/12/90	–	–	–	–	–	–	1.5	3.1	–	1.3	–	–	–	–	–
	01/29/91	N/A	N/A	N/A	N/A	–	–	1.3	2.3	–	1.1	–	–	–	N/A	N/A
	04/24/91	N/A	N/A	N/A	N/A	–	–	2.1	2.5	–	1.4	–	–	–	N/A	N/A
MW-26	09/11/89	–	–	–	–	–	–	1	–	–	2.6	–	–	–	–	50**
	02/07/90	–	–	–	–	–	–	3.2	14	–	1.3	–	–	–	N/A	N/A
	05/16/90	–	–	–	–	–	–	1.6	–	–	1.1	–	–	–	–	–
	09/12/90	–	–	–	–	–	–	2.1	5	–	1.6	–	–	–	–	–
	01/29/91	N/A	N/A	N/A	N/A	–	–	1.6	3.6	–	1	–	–	–	N/A	N/A
	04/24/91	N/A	N/A	N/A	N/A	–	–	2.4	3.4	–	1.4	–	–	–	N/A	N/A
MW-27	09/15/89	–	–	–	–	–	–	–	–	–	5.5	–	–	–	–	–
	05/21/90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	09/17/90	–	–	–	–	–	–	–	0.99	–	1.1	–	–	–	–	–
	01/29/91	N/A	N/A	N/A	N/A	–	–	–	–	–	0.7	–	–	–	N/A	N/A
	04/24/91	N/A	N/A	N/A	N/A	–	–	–	1.1	–	1.4	–	–	–	N/A	N/A

TABLE 9 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTIONS ONLY (μg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

MONITORING WELL	DATE SAMPLED	B	T	X	E	1,1,1 -TCA	1,1,2 -TCA	1,1- DCA	1,1- DCE	1,2- DCA	CHLORO FORM	PCE	TCE	CCL_4	TPH	TPH/ Gas
		MCL/AL														
		1	100*	1,750	680	200	32	5*	6	0.5	100	5	5	0.5	NE	NE
MW-28	02/15/90	–	–	–	–	–	–	5.8	1	–	0.7	–	–	–	N/A	–
	05/21/90	–	–	–	–	–	–	9.5	–	–	–	–	–	–	–	–
	09/19/90	–	–	–	–	–	–	9	4	–	–	–	–	–	–	–
	02/01/91	–	–	–	–	–	–	13.0	4.3	–	–	–	–	–	N/A	N/A
	04/30/91	–	–	–	–	–	–	8.1	3.9	–	–	–	–	–	N/A	N/A
MW-29	02/15/90	–	–	–	–	8.5	–	10	190	22	1.8	–	0.9	–	N/A	50
	04/23/90	–	–	–	–	5	–	14	72	16	1.2	–	0.87	–	N/A	N/A
	05/25/90	6.2	–	–	–	4.6	–	4.1	8.6	14	–	–	–	–	–	–
	09/06/90	–	–	–	–	3.2	–	4.4	38	11	1.3	–	0.76	1.3	–	–
	02/01/91	–	–	–	–	–	–	1.9	33	4.7	–	–	–	–	N/A	N/A
	04/30/91	–	–	–	–	–	–	2.4	16	6.6	0.57	–	–	0.68	N/A	N/A
MW-30	02/15/90	–	–	–	–	4.5	2.3	18	820	–	1.5	–	4.8	–	N/A	60
	04/23/90	1.1	–	–	–	30	–	12	470	31	–	–	8.2	–	N/A	N/A
	05/24/90	2.4	–	–	–	22	3	19	48	4.8	1.1	–	6.8	–	–	60
	09/05/90	1.2	–	–	–	14	–	11	150	–	–	–	–	–	–	–
	02/04/91	–	–	–	–	6.3	–	8.2	160	–	–	–	–	–	N/A	N/A
	04/30/91	–	–	–	–	5.9	–	9.0	75	–	–	–	–	–	N/A	N/A
MW-31	05/24/90	1.1	–	–	–	39	2.7	22	54	0.6	1.7	–	10	–	–	60
	09/19/90	0.63	–	–	–	20	–	15	160	–	–	–	7.6	–	–	–
	02/01/91	–	–	–	–	–	–	7.6	150	–	–	–	–	–	N/A	N/A
	05/01/91	–	–	–	–	5.9	–	12	110	–	–	–	7.3	–	N/A	N/A

TABLE 9 (Continued)
SUMMARY GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTIONS ONLY (μg/l)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

MONITORING WELL	DATE SAMPLED	B	T	X	E	1,1,1 -TCA	1,1,2 -TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLORO FORM	PCE	TCE	CCL_4	TPH	TPH/ Gas
		MCL/AL														
		1	100*	1.750	680	200	32	5*	6	0.5	100	5	5	0.5	NE	NE
MW-32	05/24/90	–	–	–	–	20	0.9	21	45	–	0.9	0.6	13	–	–	60
	09/19/90	–	–	–	–	15	–	18	180	–	–	–	11	–	–	–
	02/01/91	–	–	–	–	–	–	6.1	130	–	–	–	5.0	–	N/A	N/A
	05/01/91	–	–	–	–	6.4	–	11	160	–	–	–	11	–	N/A	N/A
MW-33	05/18/90	–	–	–	–	17	–	8.1	38	–	–	–	1.4	–	–	–
	09/14/90	–	–	–	–	10	–	–	120	–	–	–	–	–	–	–
	01/30/91	–	–	–	–	3.4	–	2	31	–	–	–	–	–	N/A	N/A
	04/30/91	–	–	–	–	2.4	–	2.1	33	–	–	–	–	–	N/A	N/A
MW-34	07/02/91	–	–	–	–	17	1.3	17	470	–	1.2	–	15	–	N/A	N/A
MW-35	07/02/91	–	–	–	–	6.8	–	4.8	220	–	0.7	–	3.8	–	N/A	N/A
MW-39	06/28/91	–	–	–	–	0.6	–	–	0.7	2.9	4.0	–	–	1.8	N/A	N/A
MW-40	06/28/91	–	–	–	–	4	–	19	110	–	–	–	46	–	N/A	N/A
MW-41	06/28/91	–	–	–	–	–	–	–	–	–	–	–	–	–	N/A	N/A
MW-42	06/28/91	–	–	–	–	11	–	110	340	–	2	–	4	–	N/A	N/A
MW-43	06/28/91	–	–	–	–	–	–	330	33	–	–	–	–	–	N/A	N/A

CCL_4 - Carbon Tetrachloride
MCL - Maximum Contaminant Level, Drinking Water Standard, EPA or DHS (whichever is more stringent)
AL - Drinking Water Action Level recommended by DHS, Listed in the absence of an MCL
* - Indicates DHS - AL
– - Not Detected
N/A - Not Analyzed

TABLE 10
SUMMARY HYDROPUNCH™ GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTION ONLY (μg/L)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

SAMPLE ID	DATE SAMPLED	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLOROFORM	PCE	TCE	CCL4
		MCL/AL							
		200	5*	6	0.5	100	5	5	0.5
HP-1-36	04/23/90	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HP-1-56	04/23/90	42	N/A	430	--	N/A	--	7	N/A
HP-2-36	04/23/90	--	N/A	--	--	N/A	--	--	N/A
HP-2-52	04/24/90	1	N/A	5	--	N/A	--	--	N/A
HP-3-36.5	04/24/90	--	N/A	--	--	N/A	--	--	N/A
HP-3-57	04/24/90	1	N/A	3	--	N/A	--	--	N/A
HP-4-36	04/24/90	--	N/A	1	3	N/A	--	--	N/A
HP-4-42	04/24/90	--	N/A	2	13	N/A	--	--	N/A
HP-4-42[1]	04/24/90	--	4.4	1.1	8.3	0.66	--	--	--
HP-5-42	04/25/90	--	N/A	4	--	N/A	--	--	N/A
HP-5-56	04/25/90	--	N/A	--	--	N/A	--	--	N/A
HP-6-37	04/25/90	7	N/A	63	17	N/A	--	--	N/A
HP-6-53.5	04/25/90	5	N/A	130	--	N/A	--	--	N/A
HP-7-37	04/26/90	--	N/A	5	--	N/A	--	--	N/A
HP-7-48.25	04/26/90	2	N/A	20	--	N/A	--	--	N/A
HP-8-36	04/26/90	--	N/A	--	1	N/A	--	--	N/A
HP-8-54	04/26/90	35	N/A	410	--	N/A	--	--	N/A
HP-8-54[1]	04/26/90	25	7.2	450	--	--	--	--	--
HP-9-36	04/26/90	2	N/A	17	--	N/A	--	--	N/A

SAC21.006

TABLE 10 (Continued)
SUMMARY HYDROPUNCH™ GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTION ONLY (μg/L)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

SAMPLE ID	DATE SAMPLED	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLOROFORM	PCE	TCE	CCL4
		MCL/AL							
		200	5*	6	0.5	100	5	5	0.5
HP-9-54	04/26/90	--	N/A	--	--	N/A	--	--	N/A
HP-10-35	04/27/90	--	--	--	--	N/A	--	--	--
HP-10-48	04/27/90	--	2	2	--	N/A	--	--	--
HP-11-36	04/27/90	--	--	--	--	13	--	--	--
HP-11-50	04/27/90	--	--	--	--	1	--	--	--
HP-12-38	04/30/90	--	5	23	--	--	--	--	--
HP-12-49	04/30/90	--	2	14	--	--	--	--	--
HP-13-36	04/30/90	--	--	2	2	--	--	--	--
HP-13-51	04/30/90	27	10	320	2	7	--	4	--
HP-14-37	04/30/90	1	--	14	2	2	--	--	--
HP-14-48	04/30/90	32	16	240	5	3	--	5	2
HP-15-37	05/08/90	--	--	--	--	--	--	--	--
HP-15-51	05/01/90	--	3.9	9.6	--	--	--	--	--
HP-16-36	05/01/90	1.2	--	9.5	--	1.4	--	--	0.79
HP-16-54	05/01/90	34	8.4	270	1.1	1.6	--	3.8	0.56
HP-17-37.5	05/01/90	--	--	1	--	11	--	--	--
HP-17-47	05/01/90	--	--	--	--	--	--	--	--
HP-17-54	05/01/90	--	--	--	--	--	--	--	--
HP-18-37	05/02/90	--	--	--	--	--	--	--	--

TABLE 10 (Continued)
SUMMARY HYDROPUNCH™ GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTION ONLY (μg/L)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

SAMPLE ID	DATE SAMPLED	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLOROFORM	PCE	TCE	CCL4
		MCL/AL							
		200	5*	6	0.5	100	5	5	0.5
HP-18-51	05/02/90	5	2	79	--	4	--	--	--
HP-18-51[1]	05/02/90	4	1.7	45	--	2.9	--	--	--
HP-19-38	05/02/90	--	50	170	210	--	--	--	--
HP-19-54	05/02/90	14	11	230	--	--	--	1	--
HP-20-37	05/04/90	--	1.4	4.5	--	--	--	--	--
HP-20-51[1]	05/03/90	--	0.73	1.6	--	--	--	--	--
HP-21-36[1]	05/03/90	--	--	2.1	--	--	--	--	--
HP-21-54[1]	05/03/90	3.9	3.4	52	--	--	--	1.3	--
HP-22-37[1]	05/03/90	--	--	1.3	--	--	--	--	--
HP-22-55[1]	05/03/90	5.8	8.1	69	--	--	0.55	8.3	--
HP-23-37[1]	05/03/90	--	--	2.1	--	--	0.63	--	--
HP-23-55[1]	05/03/90	1.4	2	8	--	--	--	1.6	--
HP-24-40[1]	05/04/90	--	--	--	--	0.56	--	--	--
HP-24-50[1]	05/04/90	--	--	--	--	1.8	--	--	--
HP-25-37[1]	05/04/90	--	0.51	2.1	1.6	1.1	--	--	--
HP-25-54[1]	05/04/90	4.7	5.6	44	9.4	3.8	--	--	--
HP-26-39[1]	05/07/90	1	0.76	13	--	0.51	--	--	--
HP-26-47[1]	05/07/90	8.8	5.4	140	--	0.58	--	6.5	--
HP-27-47[1]	05/08/90	--	--	--	--	--	--	--	--

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TABLE 10 (Continued)
SUMMARY HYDROPUNCH™ GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTION ONLY (μg/L)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

SAMPLE ID	DATE SAMPLED	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLOROFORM	PCE	TCE	CCL4
		MCL/AL							
		200	5*	6	0.5	100	5	5	0.5
HP-28-38	09/05/90	4	--	27	14	--	--	--	--
HP-28-53	09/05/90	26	16	140	2	1	3	3	--
HP-29-36	09/06/90	--	--	--	--	--	--	--	--
HP-29-44.5	09/06/90	--	--	--	--	6	--	--	--
HP-30-36	09/07/90	--	--	--	--	--	--	--	--
HP-30-48.5	09/07/90	--	--	--	--	--	--	--	--
HP-31-44	09/27/90	--	2	8	--	--	--	--	--
HP-31-56	09/27/90	--	--	--	--	--	--	--	--
HP-32-37	09/10/90	6	--	39	--	--	--	--	3
HP-32-43.5	09/10/90	16	9	130	31	1	--	4	--
HP-32-43.5[1]	09/10/90	18	9.8	150	29	2.2	--	2.7	--
HP-33-37	09/11/90	--	--	28	--	--	--	--	--
HP-33-44	09/11/90	6	1	62	--	--	--	4	--
HP-34-40	09/18/90	--	--	--	--	--	--	--	--
HP-34-48	09/18/90	--	--	--	--	--	--	--	--
HP-35-48	09/12/90	2	6	160	--	--	--	8	22
HP-36-39	09/13/90	19	8	100	3	7	--	3	--
HP-36-39[X]	09/13/90	3	1	43	--	--	--	--	--
HP-36-50	09/13/90	31	9	190	3	--	--	6	--

TABLE 10 (Continued)
SUMMARY HYDROPUNCH™ GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTION ONLY ($\mu g/L$)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

SAMPLE ID	DATE SAMPLED	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLOROFORM	PCE	TCE	CCL4
		MCL/AL							
		200	5*	6	0.5	100	5	5	0.5
HP-37-39.5	09/14/90	--	--	--	--	--	--	--	--
HP-37-52	09/14/90	--	--	--	--	2	--	--	--
HP-38-45	09/19/90	--	--	--	--	2	--	--	--
HP-38-55[X]	09/17/90	--	--	--	--	--	--	--	--
HP-38-55.5	09/20/90	--	--	--	--	2	--	--	--
HP-39-40.5	09/18/90	1	--	20	2	--	--	--	--
HP-39-40.5[1]	09/18/90	1.9	1	11	4.2	--	--	--	--
HP-39-48.5	09/18/90	3	3	46	6	2	--	--	--
HP-40-47.5	09/21/90	--	--	--	--	--	--	--	--
HP-40-47.5[1]	09/21/90	--	--	--	--	--	--	--	--
HP-40-58.5[1]	09/19/90	--	--	--	--	--	--	--	--
HP-41-46[1]	09/21/90	1	1	12	6	2	--	--	--
HP-41-55[1]	09/21/90	1	1	10	5	2	--	--	--
HP-41-55[2]	09/21/90	1	1.5	7	6.9	2.7	--	--	--
HP-42-45.5[1]	09/20/90	--	--	--	--	--	--	--	--
HP-42-58.5[1]	09/20/90	--	--	--	--	--	--	--	--
HP-42-58.5[2]	09/20/90	--	--	--	--	--	--	--	--
HP-43-45[1]	09/20/90	--	--	--	--	2	--	--	--
HP-43-50.5[1]	09/20/90	--	--	--	--	2	--	--	--

TABLE 10 (Continued)
SUMMARY HYDROPUNCH™ GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTION ONLY (μg/L)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

SAMPLE ID	DATE SAMPLED	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLOROFORM	PCE	TCE	CCL4
		MCL/AL							
		200	5*	6	0.5	100	5	5	0.5
HP-44-42.5[1]	09/21/90	--	--	5	3	2	--	--	--
HP-44-54.5	09/21/90	--	--	3	--	--	--	--	--
HP-44-54.5[1]	09/21/90	--	--	3.6	2	1.4	--	--	--
HP-45-46	09/24/90	--	--	--	--	2	--	--	--
HP-45-54	09/24/90	--	--	--	--	--	--	--	--
HP-46-56.5	09/25/90	--	--	11	--	--	--	--	--
HP-47-46.5	09/25/90	9	2	61	--	--	--	2	--
HP-47-56	09/25/90	--	2	62	--	--	--	2	--
HP-47-56[1]	09/25/90	11	2.3	45	--	0.78	--	2.1	1.3
HP-48-50	09/25/90	2	--	26	--	--	--	--	--
HP-48-50[1]	09/25/90	4.4	1.4	18	--	0.77	--	--	--
HP-49-56.5	09/26/90	--	--	--	--	--	--	--	--
HP-50-48	09/26/90	--	--	--	--	--	--	--	--
HP-50-58	09/26/90	--	--	--	--	--	--	--	--
HP-50-58[1]	09/26/90	--	--	--	--	0.5	--	--	0.83
HP-51-43	09/27/90	--	--	2	--	--	--	--	--
HP-51-59	09/28/90	--	--	--	--	--	--	--	--
HP-52-44	09/28/90	--	--	--	--	1	--	--	--
HP-52-56	09/28/90	--	--	--	--	--	--	--	2

TABLE 10 (Continued)
SUMMARY HYDROPUNCH™ GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTION ONLY (μg/L)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

SAMPLE ID	DATE SAMPLED	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLOROFORM	PCE	TCE	CCL4
		MCL/AL							
		200	5*	6	0.5	100	5	5	0.5
HP-53-45.5	10/01/90	--	--	--	--	--	--	--	--
HP-53-58	10/01/90	--	--	--	--	--	--	--	--
HP-54-48	10/02/90	--	--	8	4	--	--	--	--
HP-54-60	10/02/90	--	--	--	1	--	--	--	--
HP-55-49	10/02/90	--	--	5	--	--	--	--	--
HP-55-60	10/02/90	--	--	--	--	--	--	--	--
HP-56-45	10/02/90	--	--	--	--	--	--	--	--
HP-56-62	10/02/90	--	--	--	--	--	--	--	--
HP-57-44	10/03/90	--	--	--	--	--	--	--	--
HP-57-55	10/03/90	--	--	--	--	--	--	--	--
HP-58-48.5	10/03/90	--	--	--	--	--	--	--	--
HP-58-48.5[1]	10/03/90	--	--	--	1.1	1.9	--	--	--
HP-58-60	10/03/90	--	--	--	--	--	--	--	--
HP-59-47.5[X]	10/03/90	--	--	--	--	--	--	--	--
HP-59-48	10/04/90	2	1	29	4	1	--	--	--
HP-59-48[1]	10/04/90	5.2	3.6	25	5.5	2.7	--	1.3	2
HP-59-48[2]	10/04/90	4.9	3.3	30	5.3	3	--	1.5	1.1
HP-59-62	10/04/90	--	--	--	--	--	--	--	--
HP-60-48	10/04/90	--	--	3	--	--	--	--	--

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TABLE 10 (Continued)
SUMMARY HYDROPUNCH™ GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTION ONLY (μg/L)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

SAMPLE ID	DATE SAMPLED	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLOROFORM	PCE	TCE	CCL4
		MCL/AL							
		200	5*	6	0.5	100	5	5	0.5
HP-60-55	10/04/90	--	--	3	--	--	--	--	--
HP-61-48.5	10/05/90	--	--	8	--	--	--	--	--
HP-61-48.5[2]	10/05/90	1.6	0.9	7.8	0.5	2.1	--	1.5	1.2
HP-61-62	10/05/90	--	--	--	--	--	--	--	--
HP-62-47	10/05/90	--	--	--	--	--	--	--	--
HP-62-56	10/05/90	--	--	--	--	--	--	--	--
HP-63-46	10/09/90	--	--	--	5	--	--	--	--
HP-63-55.5	10/09/90	--	--	--	5	1	--	--	--
HP-64-47	10/08/90	--	--	--	--	--	--	--	--
HP-64-55	10/08/90	--	--	--	--	--	--	--	--
HP-65-50	10/08/90	--	--	--	--	--	--	--	--
HP-65-60	10/08/90	--	--	--	--	--	--	--	--
HP-66-44	10/09/90	--	--	--	--	--	--	--	--
HP-66-52	10/09/90	--	--	--	--	--	--	--	--
HP-67-47[1]	10/23/90	--	--	--	--	1.6	--	--	--
HP-67-58.5	10/10/90	--	--	--	--	--	--	--	--
HP-68-50	10/17/90	--	--	--	--	--	--	--	--
HP-68-58	10/17/90	--	--	--	--	--	--	--	--
HP-69-48.5	10/17/90	--	--	--	--	--	--	--	--

TABLE 10 (Continued)
SUMMARY HYDROPUNCH™ GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTION ONLY (μg/L)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

SAMPLE ID	DATE SAMPLED	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLOROFORM	PCE	TCE	CCL4
		MCL/AL							
		200	5*	6	0.5	100	5	5	0.5
HP-69-57	10/18/90	--	--	--	--	--	--	--	--
HP-70-48	10/19/90	--	--	--	--	--	--	--	--
HP-70-48[1]	10/19/90	--	--	--	--	--	--	--	--
HP-70-58	10/18/90	--	--	--	--	--	--	--	--
HP-71-49[1]	10/22/90	--	0.52	--	1.9	2.8	--	--	1.9
HP-71-57.5[1]	10/22/90	--	0.52	--	2.1	3.6	--	--	2.4
HP-72-48.5[1]	10/23/90	--	--	--	--	0.57	--	--	--
HP-72-58.5[1]	10/22/90	--	--	--	--	--	--	--	--
HP-73-49[1]	10/23/90	5.5	2.4	19	1.7	2.2	--	2	1.4
HP-73-56[1]	10/23/90	--	--	--	1.2	2.2	--	--	2.4
HP-74-48.5[1]	10/24/90	1.5	2.3	7.3	6.9	2.1	--	--	0.51
HP-74-48.5A[1]	10/24/90	--	--	--	--	--	--	--	--
HP-74-59.5[1]	10/24/90	--	0.7	--	3	3	--	--	1
HP-75-37.5[1]	10/24/90	15	19	260	--	--	--	--	--
HP-75-53[1]	10/24/90	2.9	17	110	--	0.69	--	0.75	--
HP-76-38.5	02/19/91	--	42	18	--	--	--	--	--
HP-76-62.5	02/19/91	--	--	--	--	--	--	--	--
HP-77-40.5	02/19/91	--	--	--	--	--	--	--	--
HP-77-65.5	02/19/91	--	--	--	--	--	--	--	--

TABLE 10 (Continued)
SUMMARY HYDROPUNCH™ GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTION ONLY (μg/L)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

SAMPLE ID	DATE SAMPLED	1,1,1-TCA	1,1-DCA	1,1-DCE	1,2-DCA	CHLOROFORM	PCE	TCE	CCL4
		MCL/AL							
		200	5*	6	0.5	100	5	5	0.5
HP-78-41.5	02/19/91	--	160	260	--	--	--	4	--
HP-78-60	02/19/91	--	--	--	--	--	--	--	--
HP-79-40	02/20/91	--	--	--	--	--	--	--	--
HP-79-59.5	02/20/91	--	--	--	--	--	--	--	--
HP-80-37	02/20/91	--	--	--	--	--	--	--	--
HP-80-56	02/20/91	--	--	--	--	--	--	--	--
HP-81-38	02/20/91	--	2	74	--	--	--	--	--
HP-81-38[3]	02/20/91	--	3	90	--	--	--	2	--
HP-81-56	02/20/91	--	--	--	--	--	--	--	--
HP-82-56	02/20/91	--	--	--	--	--	--	--	--
HP-83-37.5	02/20/91	--	230	160	--	--	--	--	--
HP-83-48.5	02/21/91	--	--	--	--	--	--	--	--
HP-84-38	02/21/91	--	--	5	--	--	--	--	--
HP-85-39.5	02/21/91	--	--	53	--	9	--	--	4

TABLE 10 (Continued)
SUMMARY HYDROPUNCH™ GROUNDWATER ANALYTICAL RESULTS
ORGANIC COMPOUNDS - DETECTION ONLY ($\mu g/L$)
UNION PACIFIC SACRAMENTO YARD
SACRAMENTO, CALIFORNIA

Sample ID HP and the first two numbers indicate sample location number. Last two numbers indicate depth in feet below ground surface
CCl_4 - Carbon Tetrachloride
MCL - Maximum Contaminant Level Drinking Water Standard, EPA or DHS, whichever is more stringent.
AL - Drinking Water Action Level recommended by DHS, listed in the absence of an MCL.
* - Drinking Water Action Level(AL)
1 - Indicates the sample was analyzed by Enseco Stationary Laboratory. Entries with no superscript were analyzed by Enseco Mobile Laboratories.
2 - Indicates the sample was analyzed by Acculab Stationary Laboratory.
3 - Indicates the sample was analyzed by Superior Analytical Stationary Laboratory.
-- - Not Detected.
NA - Not Analyzed.
X - Indicates the sample experienced excessive air contact and was resampled
Dual entry for a sample indicates both an original and a duplicate sample were analyzed. The second represents the results of the duplicate which was analyzed by a stationary lab.

TABLE 11
REVISED BASELINE HEALTH RISK ASSESSMENT SUMMARY
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Land Use	Exposed Populations	Estimated Lifetime Cancer Risk	Chemicals Associated with Highest Risks	Major Exposure Pathways	Noncancer Hazard Indices	Chemicals with Hazard Indices Exceeding 1.0
Current Land Use	Intruder - Adult	2.8×10^{-4}	Arsenic	Soil Ingestion, Inhalation	<1	
	Intruder - Child	1.4×10^{-3}	Arsenic	Soil Ingestion, Inhalation	>1	Antimony
	Off-site Resident - Adult	2.0×10^{-4}	Arsenic	Fruit and Vegetable Ingestion, Inhalation	<1	
	Off-site Resident - Child	9.0×10^{-4}	Arsenic	Fruit and Vegetable Ingestion, Inhalation	<1	
Future Land Use	Off-site Resident - Adult	9.2×10^{-4}	Arsenic	Fruit and Vegetable Ingestion, Inhalation	<1	
			1,1-Dichloroethene	Inhalation during Showering, Ground Water Ingestion		
	Off-site Resident - Child	2.9×10^{-3}	Arsenic	Fruit and Vegetable Ingestion, Inhalation	<1	
			1,1-Dichloroethene	Ground Water Ingestion		
	On-site Resident - Adult	4.0×10^{-3}	Arsenic	Fruit and Vegetable Ingestion, Inhalation	>1	Arsenic, Copper, Naphthalene, Thallium, Zinc
			1,1-Dichloroethene	Inhalation during Showering, Ground Water Ingestion		
			Benzene	Inhalation during Showering, Ground Water Ingestion		
	On-site Resident - Child	1.7×10^{-2}	Arsenic	Fruit and Vegetable Ingestion, Inhalation	>1	Antimony, Arsenic, Copper, Naphthalene, Thallium, Zinc
			1,1-Dichloroethene	Ground Water Ingestion		
			Benzene	Ground Water Ingestion		

TABLE 12
REMEDIAL ACTION OBJECTIVES - SOIL
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Exposure Scenario and Pathway	Chemical	Concentration in Surface Soil (mg/kg)		Detection Limit (mg/kg)	Background Average Sample Concentration (mg/kg)[1]	Regional Background Concentration Range (mg/kg)[2]	Residual Risk-Based Concentration (mg/kg)	ARAR/TBC[3]		Selected Remedial Action Objective (mg/kg)	Comments
		Maximum	Average					Value (mg/kg)	Source		
Future land use - hypothetical on-site child resident											
Direct contact with soil	Arsenic	600	39	0.6	8	6-16	0.044[4]	500	TTLC[5]	8	Risk-based concentratio n in soil cannot be achieved.
	Lead	405	5,190	1.4	22	10-150	190	1,000	TTLC	190	
	Carcinogenic PAHs	18	1.77	Varies	-	-	0.042[4]	-	-	0.042	
	Non-carcinogenic PAHs	67.9	7	Varies	-	-	-	100	AAL[6]	100	
Migration from soil to groundwater.	TPH (diesel)	269,000	16,587	-	-	-	NA	NA	NA	NA	Dependent upon depth to groundwater. See Table 13.
Asbestos IRM	Asbestos	3%	<1%	~1%	-	-	-	1%	See comments	1%	Definition of asbestos-containing material under ____

[1]Average of park soil sample analyses.
[2]Shacklette and Boergnan, 1984.
[3]Applicable and Relevant or Appropriate Requirements/To Be Considered
[4]Concentration in soil equivalent to a 10^{-6} increased lifetime cancer risk.
[5]Total Threshold Limit Concentration
[6]Applied Action Level
-Not available
NA - Not Applicable.

SECTION6.TAB

TABLE 13

REMEDIAL ACTION OBJECTIVES — SOIL
DEPTH-DEPENDENT RAOs FOR TPH IN SOILS
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA[1]

Distance from GW (ft.)	Allowable TPH in Soil (ppm)	Equivalent Soluble Naphthalene[2] (mg/L) in pore water
35	15,000	30[2]
30	15,000	30[2]
26	15,000	30[2]
25	12,250	30[2]
24	9,500	30[2]
23	6,750	30[2]
22	4,000	30[2]
13	4,000	30[2]
12	3,000	23
11	2,000	15
10	1,000	8
8	500	4
5	100	0.8

1 Source: Appendix I of this Addendum.
2 Even when TPH is high in soil, the physical and chemical characteristics of naphthalene and water allow no more than 30 mg/L of naphthalene to be solubilized in pore water under saturated conditions.

TABLE 14
REMEDIAL ACTION OBJECTIVES - GROUNDWATER
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Exposure Scenario and Pathway	Chemical	Maximum Concentration Detected in Groundwater (ug/L)[1]	Detection Limit (ug/L)	Regional Background Concentration Range (ug/L)[2]	Residual Risk-Based Concentration (ug/L)	ARAR/TBC[3]		Selected Remedial Action Objective (ug/L)	Comments
						Value (ug/L)	Source		
Future land use - hypothetical on-site child resident									
Ingestion of groundwater	Nickel	450	5	-	-	400	AAL	400	Maximum concentration exceeds state AAL.
	Arsenic	30	5	0-20	0.0076[3]	50	MCL[4]	50	MCLs selected based on feasibility of control methods and/or ability to detect chemical in water.
	1,1-Dichloroethane	22	0.5	-	0.14[3]	5	MCL	5	
	1,1-Dichloroethene	820	0.5	-	0.021[3]	6	MCL	6	RAO based on non-carcinogenic effects.
	1,2-Dichloroethane	360	0.5	-	0.14[3]	0.5	MCL	0.5	
	Benzene	12,000	0.5	-	0.44[3]	1	MCL	1	
	Ethylbenzene	1,200	0.5	-	1,240	680	AAL[5]	680	
	Trichloroethene	13	0.5	-	1[3]	5	MCL	5	

[1]Concentration detected in on-site groundwater.
[2]Johnson, 1985.
[3]Concentration equivalent to a 10^{-6} increased lifetime cancer risk.
[4]State Maximum Contaminant Limit.
[5]Applied Action Level.

TABLE 15

VOLUMES OF AFFECTED SOILS
ABOVE REMEDIAL ACTION OBJECTIVES AND HOT SPOT LEVELS
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Target Chemicals/ Materials	0-0.5	0.5-1.5	1.5-5	5-10	10-15	15-20	Bulk	Total Cubic Yards
Soil Operable Unit S-1								
VOLUME ABOVE RAOS (IN CUBIC YARDS)								
As ≥ 8mg/kg	20,000	21,700	14,200	17,900	—	—	—	73,800
Pb ≥ 190 mg/kg	10,300	4,400	2,200	700	—	—	—	17,600
VOLUME ABOVE HOT SPOT LEVELS (IN CUBIC YARDS)**								
As ≥ 75 mg/kg	1,400	1,000	900	—	—	—	—	3,300
Pb ≥ 500 mg/kg	2,900	2,000	600	—	—	—	—	5,500
Soil Operable Unit S-2								
VOLUME ABOVE RAOS (IN CUBIC YARDS)								
As ≥ 8 mg/kg	1,700	2,200	15,600	17,100	—	—	—	36,600
PB ≥ 190 mg/kg	700	800	10,000	3,200	—	—	—	14,700
TPH*	70		5,600	4,900	1,000	—	—	11,570
PAH***	NA	NA	NA	NA	NA	NA	NA	NA
Drums	—	—	—	—	—	—	400	36
VOLUME ABOVE HOT SPOT LEVELS (IN CUBIC YARDS)**								
As ≥ 75 mg/kg	40	—	2,700	—	—	—	—	2,740
PB ≥ 500 mg/kg	110	70	6,100	1,500	—	—	—	7,780
TPH* ≥ 15,000	70		1,700	1,100	—	—	—	2,870
Soil Operable Unit S-3								
VOLUME ABOVE RAOS (IN CUBIC YARDS)								
As ≥ 8 mg/kg	2,900	200	12,000	700	—	—	—	15,800
Pb ≥ 190 mg/kg	1,700	200	900	—	—	—	—	2,800
TPH*	120		—	—	—	—	—	—
VOLUME ABOVE HOT SPOT LEVELS (IN CUBIC YARDS)**								
As ≥ 75 mg/kg	100	—	—	—	—	—	—	100
Pb ≥ 500 mg/kg	20	—	—	—	—	—	—	20
Soil Operable Unit S-4								
VOLUME ABOVE RAOS (IN CUBIC YARDS)								
As ≥ 8 mg/kg	600		NA	NA	NA	NA	NA	600
Pb ≥ 190 mg/kg			NA	NA	NA	NA	NA	
VOLUME ABOVE HOT SPOT LEVELS (IN CUBIC YARDS)								
As ≥ 75 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA
Pb ≥ 500 mg/kg	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 15

VOLUMES OF AFFECTED SOILS
ABOVE REMEDIAL ACTION OBJECTIVES AND HOT SPOT LEVELS
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA
(Continued)

Legend:

NA — Not Applicable

As — Arsenic

Pb — Lead

TPH — Total Petroleum Hydrocarbons

* — TPH remedial action objective and definition is depth-dependent (see Table 13). TPH hot spot level is 15,000 mg/kg. This concentration represents the level at which TPH may move freely in soil without consideration of infiltration.

** Reader should note that overlap may occur between hot spots and other areas where RAOs for Pb, As and TPH are exceeded; contour maps should be used for cross reference.

*** The data for PAH contamination is currently insufficient to estimate the volume of PAH-contaminated soil above RAOs.

— None detected.

TABLE 16

GROUNDWATER OPERABLE UNIT VOLUMES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Operable Unit	Area (Acres)	Thickness[1] (feet)	Porosity[1] (%)	Volume	
				(Ft³)	Gallons
GW-1	35.4	20-35	25-30	19.4×10^6	145×10^6
GW-2	4.5	15	30	0.89×10^6	6.6×10^6

1 Source: Dames & Moore, 1991f.

Note: The volume of each operable unit which is shown is different than the total volume of water to be removed during remediation. This volume is likely to be 2 to 5 times the volume shown.

TABLE 17

APPLICABILITY OF SOIL ALTERNATIVES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Alternative No./Name	Operable Units			
	S-1 — Arsenic, Lead, TPH, Asbestos (Inactive Portion of Site)	S-2 — Arsenic, Lead, TPH (Central Fill Area — Inactive Portion of Site)	S-3 — Arsenic, Lead, TPH (Northern-most Inactive Portion of Site)	S-4 — Arsenic, Lead (Off-site Contamination)
1 — No Action	Applicable	Applicable	Applicable	Applicable
2 — Limited Action with Institutional Controls	Applicable	Applicable	Applicable	Not Applicable
3 — Revegetation	Not Applicable	Not Applicable	Not Applicable	Not Applicable
4 — Containment	Applicable	Not Applicable	Applicable	Not Applicable
5 — Excavation/On-Site Treatment of Hot Spots with Capping	Applicable	Not Applicable	Applicable	Applicable
6 — Excavation/Off-Site Disposal of Hot Spots with Capping	Applicable	Applicable	Applicable	Applicable
7 — Excavation/Off-Site Treatment/Disposal of Hot Spots with Capping	Applicable	Not Applicable	Applicable	Applicable
8 — In-Situ Treatment - Soil Above RAOs	Not Applicable	Not Applicable	Not Applicable	Not Applicable
9 — Excavation and Treatment - Soil Above RAOs	Applicable	Not Applicable	Applicable	Applicable
10 — Excavation/Off-Site Disposal of Soil Above RAOs	Applicable	Applicable	Applicable	Applicable

TABLE 18
SOIL ALTERNATIVE SCREENING
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Alternative No.	OPERABLE UNITS															
	Op Unit S-1			Eliminated (E) or Retained (R)	Op Unit S-2			Eliminated (E) or Retained (R)	Op Unit S-3			Eliminated (E) or Retained (R)	Op Unit S-4			Eliminated (E) or Retained (R)
	Effect.	Implement	Cost Effect.		Effect.	Implement	Cost Effect.		Effect.	Implement	Cost Effect		Effect.	Implement	Cost	
1	Moderate	Moderate	High	R	Low	Moderate	High	R	Moderate	Moderate	High	R	Low	Moderate	High	R
2	Moderate	Moderate	High	E	Low	Moderate	High	E	Moderate	Moderate	High	E	NA	NA	NA	E
3	NA	NA	NA	E	NA	NA	NA	E	NA	NA	NA	E	NA	NA	NA	E
4	High	High	Moderate	R	NA	NA	NA	E	High	High	Moderate	R	NA	NA	NA	E
5	Moderate	Moderate	Low	R	NA	NA	NA	E	Moderate	Moderate	Low	R	Moderate	Low	Low	E
6	High	High	Low	R	High	High	Low	R	High	High	Moderate	R	Moderate	Moderate	Moderate	E
7	High	Low	Low	E	NA	NA	NA	E	High	Low	Low	E	Moderate	Low	Low	E
8	NA	NA	NA	E	NA	NA	NA	E	NA	NA	NA	E	NA	NA	NA	E
9	Moderate	Low	Low	E	NA	NA	NA	E	Moderate	Low	Low	E	High	Moderate	Low	E
10	High	Moderate	Low	R	High	Moderate	Low	R	High	Moderate	Low	R	High	High	Moderate	R

NA = Not applicable.

Note: Cost effectiveness refers to the ability of alternatives to provide adequate protection of public health and the environment at a cost which is comparable to other alternatives which demonstrate the same degree of protection. Thus, an alternative which has low relative cost would have high cost effectiveness.

TABLE 19

GROUNDWATER ALTERNATIVE SCREENING
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Alternative	OPERABLE UNITS							
	Groundwater Operable Unit GW-1				Groundwater Operable Unit GW-2			
	Effectiveness	Implementability	Cost Effectiveness	Eliminated (E) or Retained (R)	Effectiveness	Implementability	Cost Effectiveness	Eliminated (E) or Retained (R)
No. 1 — No Action	Low	Low	High	R*	Low	Low	High	R*
No. 2 — Limited Action	Low	Low	High	E	Moderate	Moderate	High	R
No. 3 — Hydraulic Containment	Moderate	Low	Low	E	Moderate	Moderate	Low	E
No. 4 — Extract/Treat/Discharge	High	Moderate	Low	R	High	Moderate	Low	R
No. 5 — Extract/Treat/Reclaim	High	Low	Low	E	High	Low	Low	E
No. 6 — In Situ Bioremediation	Unknown	Low	High	E	Unknown	Low	High	E

* Consideration of the No Action alternative is required by the National Contingency Plan (EPA, 1990).

Note: Cost effectiveness refers to the ability of alternatives to provide adequate protection of public health and the environment at a cost which is comparable to other alternatives which demonstrate the same degree of protection. Thus, an alternative which has a low relative cost would have high cost effectiveness.

TABLE 20

SUMMARY OF IMPLEMENTATION TIMES
SOIL ALTERNATIVES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Alternative	Operable Unit	Design (Weeks) *	Permitting (Weeks) *	Construction (Weeks)	Operation and Maintenance (Years)*	Total (Years)
1 No Action	S-1	4	8	8	30	30.3
	S-2	4	8	3	30	30.2
	S-3	4	8	4	30	30.2
	S-4	4	8	2	30	30.2
4 Containment/ Institutional Controls	S-1	12	12	27	30	30.7
	S-3	12	12	12	30	30.5
5 Excavation/On-Site Treatment of Hot Spots with Capping	S-1	12	24	48	30	31.4
	S-3	12	12	17	30	30.6
6 Excavation/Off-Site Disposal of Hot Spots with Capping	S-1	12	12	30	30	30.8
	S-2	12	12	27	30	30.7
	S-3	12	12	13	30	30.5
10 Excavation/Off-Site Disposal of Soil Above RAOs	S-1	8	12	27	0	0.7
	S-2	8	12	24	0	0.7
	S-3	8	12	16	0	0.5
	S-4	8	8	6	0	0.3

* Design time for No Action alternative includes time for preparation of groundwater monitoring work plan. Permitting times include time for DTSC review and approval of work plan plus development, review and approval of deed restrictions. Operation and maintenance times include fence repair and/or replacement. Permitting period is concurrent with design period.

TABLE 21

SUMMARY OF ESTIMATED COSTS
SOIL ALTERNATIVES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Alternative	Operable Unit	Capital Costs*	Operation and Maintenance Costs**	Total Costs	Total Present Worth Cost*** (1991 $)
1 No Action	S-1	105,000	1,170,000	1,275,000	803,000
	S-2	30,000	1,170,000	1,200,000	731,000
	S-3	53,000	1,170,000	1,223,000	753,000
	S-4	6,000	1,170,000	1,176,000	709,000
4 Containment/ Institutional Controls	S-1	3,563,000	2,483,000	6,046,000	4,748,000
	S-3	659,000	1,469,000	2,128,000	1,480,000
5 Excavation/On-Site Treatment of Hot Spots with Capping	S-1	8,956,000	1,313,000	10,269,000	9,181,000
	S-3	730,000	299,000	1,029,000	845,000
6 Excavation/Off-Site Disposal of Hot Spots with Capping	S-1	5,932,000	1,313,000	7,245,000	6,301,000
	S-2	4,570,000	298,000	4,868,000	4,501,000
	S-3	688,000	299,000	987,000	804,000
10 Excavation/Off-Site Disposal of Soil Above RAOs	S-1	20,157,00 0	0	20,157,000	19,197,000
	S-2	11,809,00 0	0	11,809,000	11,247,000
	S-3	4,484,000	0	4,484,000	4,270,000
	S-4	162,000	0	162,000	155,000

* All capital costs are expended in the first year of the project life.

** O&M costs are not constant over the project life.

*** Net present worth cost at 5% annual interest rate. Total present worth costs are presented in 1991 dollars.

TABLE 22

SUMMARY OF IMPLEMENTATION TIMES
GROUNDWATER ALTERNATIVES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Alternative	Operable Unit	Design (weeks)	Permitting (weeks)	Construction (weeks)	Operation and Maintenance (years)	Total (years)
1 No Action	GW-1	0	0	0	0	0
	GW-2	0	0	0	0	0
2 Limited Action	GW-2	12[1]	24[1]	0	30	30.7
4 Extract/Treat/ Discharge	GW-1	12	24	12	3 to 30	4 to 31
	GW-2	12	24	8	3	3.6

1 For the Limited Action Alternative, design consists of preparation, review, and approval of a work plan outlining the groundwater monitoring program.

Note: When a range of operation and maintenance times is presented, the low end of the range corresponds to a high flow scenario (i.e., 10 wells pumping at 20 gpm each for 3 years). The high end of the range corresponds to a low flow scenario (i.e., 2 wells pumping at 10 gpm each for 30 years).

TABLE 23

SUMMARY OF ESTIMATED COSTS
GROUNDWATER ALTERNATIVES
RI/FS ADDENDUM
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Alternative	Operable Unit	Capital Costs	Operation and Maintenance Costs	Demolition Costs	Total Costs	Total Present Worth Costs
1 No Action	GW-1	0	0	0	0	0
	GW-2	0	0	0	0	0
2 Limited Action	GW-2	0	$292,500	$8,000	$292,500	$175,700
4 Extract/ Treat/ Discharge	GW-1[1]	$315,250 - $1,708,200	$1,163,000 - $2,382,000	$8,000	$1,486,250 - $3,367,200	$978,200 - $3,131,30 0
	GW-2	$105,300 - $193,700	$124,400 - $240,500	$8,000	$237,700 - 442,200	$220,400 - 410,000

1. Range of costs dependent on number of wells, flow rate and treatment system used.

Note: Net present worth costs assume a 5 percent rate of return. Total present worth costs are presented in 1991 dollars. When a range of costs is presented for GW-1, the lower cost represents a low flow scenario (i.e., 2 extraction wells pumping at 10 gpm each for 30 years). The higher cost represents a high flow scenario (i.e., 10 extraction wells pumping at 20 gpm each for 3 years). Range of costs for GW-2 is dependent on treatment system used.

TABLE 24

SUMMARY AND COMPARISON
SOIL ALTERNATIVES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Operable Unit	Alternative	Short-term Effectiveness	Long-term Effectiveness	Reduction of T,M,V	Implement-ability	Cost*	Compliance with ARARs	Overall Protection of Public Health and Environment	State Acceptance	Community Acceptance
S-1	1	Fair	Poor	Poor	Fair	$803,000	Poor	Poor	Unknown	Unknown
	4	Fair	Good	Fair	Good	$4,748,000	Good	Good	Unknown	Unknown
	5	Fair	Good	Good	Fair	$9,181,000	Good	Good	Unknown	Unknown
	6	Fair	Good	Fair	Good	$6,301,000	Good	Good	Unknown	Unknown
	10	Poor	Good	Fair	Fair	$19,197,000	Good	Good	Unknown	Unknown
S-2	1	Fair	Poor	Poor	Fair	$731,000	Poor	Poor	Unknown	Unknown
	6	Fair	Good	Fair	Good	$4,501,000	Good	Good	Unknown	Unknown
	10	Poor	Good	Fair	Fair	$11,247,000	Good	Good	Unknown	Unknown
S-3	1	Fair	Poor	Poor	Fair	$753,000	Poor	Poor	Unknown	Unknown
	4	Fair	Good	Fair	Good	$1,480,000	Good	Good	Unknown	Unknown
	5	Fair	Good	Good	Fair	$845,000	Good	Good	Unknown	Unknown
	6	Fair	Good	Fair	Good	$804,000	Good	Good	Unknown	Unknown
	10	Poor	Good	Fair	Fair	$4,270,000	Good	Good	Unknown	Unknown
S-4	1	Poor	Poor	Poor	Poor	$709,000	Poor	Poor	Unknown	Unknown
	10	Poor	Good	Fair	Good	$155,000	Good	Good	Good	Good

* Net present worth cost of the alternative in 1991 dollars as calculated over a 30-year span using a 5% interest rate.

Note: State and community acceptance of alternatives is currently unknown. Additional information on this issue will become available during and after the State's review of the RI/FS Addendum.

Alternative 1 — No Action
Alternative 4 — Containment with Institutional Controls
Alternative 5 — Excavation/On-site Treatment of Hot Spots with Capping
Alternative 6 — Excavation/Off-site Disposal of Hot Spots with Capping
Alternative 10 — Excavation and Off-site Disposal of Soil Above RAOs

TABLE 25

SUMMARY AND COMPARISON OF
GROUNDWATER ALTERNATIVES
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

Operable Unit	Alternative	Short-term Effectiveness	Long-term Effectiveness	Reduction of Toxicity, Mobility and Volume	Implementability	Cost*	Compliance with ARARs	Overall Protection of Human Health and Environment	State** Acceptance	Community** Acceptance
GW-1	1 No Action	Poor	Poor	Poor	Fair	0	Poor	Poor	Poor	Unknown
	4 Extract/ Treat/ Discharge	**Good**	**Good**	**Good**	**Good**	**$978,200 - $3,131,300**	**Good**	**Good**	**Unknown**	**Unknown**
GW-2	1 No Action	Poor	Poor	Poor	Fair	0	Poor	Poor	Poor	Unknown
	2 Limited Action	**Fair**	**Good**	**Fair**	**Fair**	**$175,700**	**Fair**	**Good**	**Poor**	**Unknown**
	4 Extract/ Treat/ Discharge	Good	Good	Good	Good	$220,400 - $410,000	Good	Good	Unknown	Unknown

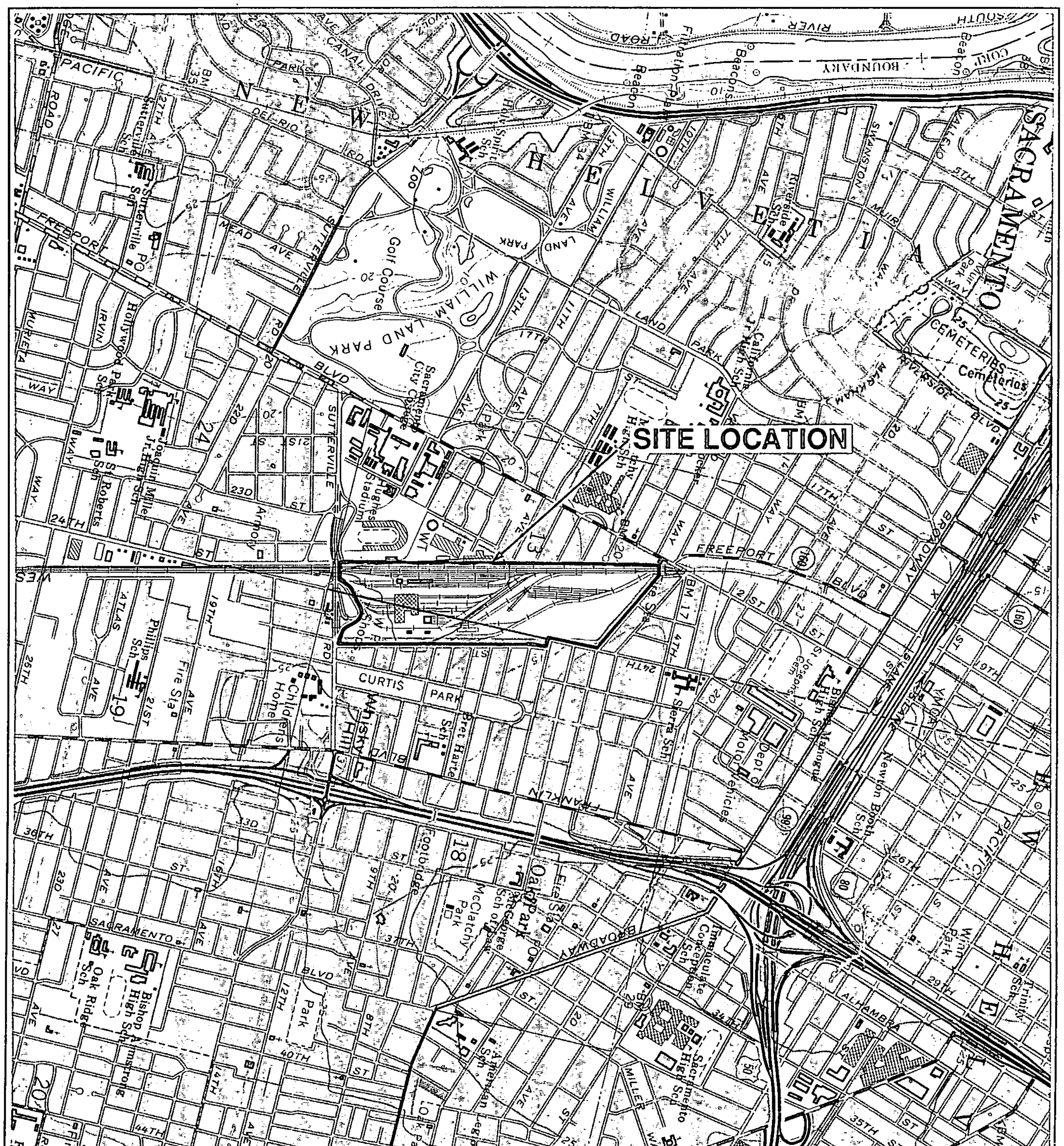
* When range of costs is presented for GW-1, lower cost = 2 wells pumping at 10 gpm each for 30 years. Higher costs = 10 wells pumping at 20 gpm each for 30 years. For GW-2, lower cost is for air stripping; higher cost is for UV/Oxidation.

** The ability of each alternative to satisfy these criteria will not be known until State review of the RI/FS Addendum.

TABLE 1
SUMMARY SOIL ANALYTICAL RESULTS
ASBESTOS (%)
UNION PACIFIC RAILROAD YARD
SACRAMENTO, CALIFORNIA

COORDINATE	DEPTH (ft bgs)	RESULTS	COORDINATE	DEPTH (ft bgs)	RESULTS
GRID SAMPLES					
310E, 480N	0.0 - 0.5	—	370E, 540N	0.0 - 0.5	0.1%
310E, 480N	0.5 - 1.0	—	370E, 540N	0.5 - 1.0	0.1%
310E, 500N	0.0 - 0.5	—	370E, 560N	0.0 - 0.5	0.1%
310E, 500N	0.5 - 1.0	—	370E, 560N	0.5 - 1.0	0.2%
310E, 520N	0.0 - 0.5	—	370E, 580N	0.0 - 0.5	0.1%
310E, 520N	0.5 - 1.0	—	370E, 580N	0.5 - 1.0	0.1%
310E, 540N	0.0 - 0.5	—	390E, 480N	0.0 - 0.5	0.1%
310E, 560N	0.0 - 0.5	—	390E, 480N	0.5 - 1.0	0.6%
310E, 560N	0.5 - 1.0	—	390E, 500N	0.0 - 0.5	0.1%
310E, 580N	0.0 - 0.5	—	390E, 500N	0.5 - 1.0	0.6%
310E, 580N	0.5 - 1.0	—	390E, 520N	0.0 - 0.5	0.1%
330E, 480N	0.0 - 0.5	—	390E, 520N	0.5 - 1.0	1.0%
330E, 480N	0.5 - 1.0	—	390E, 540N	0.0 - 0.5	0.2%
330E, 500N	0.0 - 0.5	—	390E, 540N	0.5 - 1.0	0.8%
330E, 500N	0.5 - 1.0	—	390E, 560N	0.0 - 0.5	0.2%
330E, 520N	0.0 - 0.5	—	390E, 560N	0.5 - 1.0	0.1%
330E, 520N	0.5 - 1.0	—	390E, 580N	0.0 - 0.5	0.1%
330E, 540N	0.0 - 0.5	—	390E, 580N	0.5 - 1.0	0.6%
330E, 560N	0.0 - 0.5	—	410E, 480N	0.0 - 0.5	0.8%
330E, 560N	0.5 - 1.0	—	410E, 480N	0.5 - 1.0	0.1%
330E, 580N	0.0 - 0.5	0.1%	410E, 500N	0.0 - 0.5	0.1%
330E, 580N	0.5 - 1.0	—	410E, 500N	0.5 - 1.0	0.2%
350E, 480N	0.0 - 0.5	—	410E, 520N	0.0 - 0.5	0.1%
350E, 480N	0.5 - 1.0	—	410E, 520N	0.5 - 1.0	0.1%

Figures



REFERENCE: USGS Quadrangle 7.5 Minute, Sacramento

N

0 2000

Scale in Feet

SITE LOCATION MAP

Union Pacific Railroad Yard
Sacramento, California
NOVEMBER 1991
FIGURE 1

DAMES & MOORE

00173-064-044