FINAL

Union Pacific Railroad Company

Feasibility Study Report
Ashland Rail Yard
Ashland, Oregon

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Timothy S. McCormack, R.G.
Principal-in-Charge

A. Michael Arnold
Project Manager

Environmental Resources Management
915-118th Avenue S.E., Suite 130
Bellevue, WA 98005

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LIST OF ACRONYMS

AST	Aboveground storage tank
bgs	Below ground surface
COC	Constituent of concern
CPT	Cone penetrometer testing
EDTA	Ethylenediaminetetraacetic acid
EMCON	EMCON Northwest, Inc.
ERM	Environmental Resources Management
FS	Feasibility Study
IC	Industrial Compliance
LMSA	Locomotive Maintenance and Service Area
MCLs	Maximum contaminant levels
µg/L	Micrograms per liter
O&M	Operation and maintenance
OAR	Oregon Administrative Rule
ODEQ	Oregon Department of Environmental Quality
ONHP	Oregon Natural Heritage Program
PAH	Polynuclear aromatic hydrocarbon
PPE	Personal protective equipment
PRG	Preliminary remediation goal
RI	Remedial Investigation
RRA	Residual Risk Assessment
SPTCo	Southern Pacific Transportation Company
TPH	Total petroleum hydrocarbons
UPRR	Union Pacific Railroad Company
USEPA	United States Environmental Protection Agency
VCA	Voluntary Cleanup Agreement
VOC	Volatile organic compound

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1.0 INTRODUCTION

On behalf of Union Pacific Railroad Company (UPRR), Environmental Resources Management (ERM) has prepared this Final *Feasibility Study Report* (Final FS Report) to address the remediation of soils affected by metals, polynuclear aromatic hydrocarbons (PAHs), and petroleum hydrocarbon constituents at the UPRR rail yard in Ashland, Oregon (Figure 1-1). This Final FS Report was prepared to satisfy the requirements of the Voluntary Cleanup Agreement (VCA) between UPRR and the Oregon Department of Environmental Quality (ODEQ) (VCA No. ECVC-SWR-93-02), which requires the completion of a Remedial Investigation/Feasibility Study for the UPRR Ashland Yard (Yard).

This Final FS Report was prepared based on the results of the *Final Remedial Investigation Report* (Final RI Report) prepared for the Yard (ERM, 1999). The Final FS Report has been prepared in accordance with ODEQ's *Final Guidance for Conducting Feasibility Studies* (ODEQ, 1998a).

This Final FS Report summarizes the findings of the remedial investigations, establishes remedial action objectives, and provides an evaluation of remedial technologies and alternatives. These alternatives are developed and screened against ODEQ-established evaluation criteria (ODEQ, 1998a).

Following this introduction, this FS is organized into the six sections as follows:

- Section 2 summarizes information presented in the Remedial Investigation (RI) report for the Yard, including site background and setting, prior investigative activities and results, previous removal actions, a beneficial use survey, and a risk assessment. It also delineates areas of concern and areas requiring remediation based on cleanup goals established for a future, commercial/residential, mixed-land-use scenario.
- Section 3 presents the remedial action objectives for the site.
- Section 4 develops five remedial action alternatives by first identifying and screening remedial technologies, then assembling the technologies that met screening criteria.

- Section 5 includes a detailed analysis of the five remedial action alternatives based on the ODEQ-established evaluation criteria (ODEQ, 1998a), and a comparative analysis of the alternatives.
- Section 6 presents the recommended remedial action alternative that best satisfies the ODEQ evaluation criteria, and a quantitative residual risk assessment to evaluate post-remediation risks.
- Section 7 presents a list of references used in the preparation of this report.

2.0 SITE CHARACTERIZATION

This section provides a general overview of the site and surrounding areas, and the investigative and construction activities performed at the Yard to date. A description of the source, nature, and extent of impacts is presented, along with an evaluation of the need for interim action at the Yard. The results of the beneficial use survey and risk assessment conducted as part of the RI are also summarized. Background information on the site, investigation activities, and removal actions is provided in detail in the Final RI Report, Volumes I and II.

2.1 SITE DESCRIPTION AND BACKGROUND

This subsection provides a general description of the site, including location and surrounding land use, current and historical activities and operations, regional and site-specific geology and hydrogeology, and surface water hydrology.

2.1.1 Site Location and General Setting

The Yard is at 536 A Street in the city of Ashland in Jackson County, Oregon. Ashland lies within the Bear Valley in southwestern Oregon, at approximately 2,000 feet above mean sea level. The site and surrounding area are shown on Figure 1-1.

The Yard is currently inactive and is being considered for sale and redevelopment. The adjacent property to the north is currently under development for a mixture of residential, industrial, and commercial land use. Agricultural and residential properties border the site to the east and west, and residential and commercial properties border the site to the south. A current zoning map, including the Yard and surrounding areas, is shown on Figure 2-1.

2.1.2 Site History

The Yard operated as a locomotive maintenance, service, and railcar repair facility between 1887 and 1986. Various structures (including a hotel/passenger station, a freight station, a car repair shed, a turntable, a roundhouse, and miscellaneous work and storage buildings) were once present at the Yard. A steel, 55,000-barrel (3.025-million gallon) aboveground, Bunker C oil tank, used for fueling steam locomotives, was installed at the Yard around the turn of the century, and removed in the late 1940s. The locations of historic structures and features at the Yard are shown on Figure 2-2.

Development of the Yard reached its peak in the early 1900s, with some additional construction performed during the 1920s. Light locomotive maintenance and car repair functions were performed by the Southern Pacific Transportation Company (SPTCo), UPRR's predecessor, from the 1900s until the early 1970s. Most locomotive maintenance and fueling facilities were decommissioned before 1960. Diesel and steam locomotive fueling operations were performed in the same location and, similar to car repair activities, were limited to a relatively small area of the Yard. No railroad maintenance activities were performed west of the car repair shed, or east of the drip slab. UPRR acquired SPTCo and many of its assets, including the Ashland Yard, in fall 1997.

A more detailed discussion of the site history is provided in the *Phase I Remedial Investigation Letter Report* (Industrial Compliance [IC], 1994).

2.1.3 *Historical Facility Operations*

Two, general facility operation areas are present at the Yard. The first area is the Locomotive Maintenance and Service Area (LMSA), which includes the former drip slab foundation, the former roundhouse, and the Pond C area. The second area is the Former Car Repair Shed Area. These areas are shown on Figure 2-2. Historical operations performed in these areas are discussed below.

Locomotive refueling operations were performed at the location of the former drip slab foundation. Steam locomotives were refueled with Bunker C fuel oil from a 55,000-barrel, aboveground storage tank (AST) located in this area. This tank was removed when diesel locomotives were brought into service (1955). The drip slab was installed in the mid-1980s to prevent the migration of diesel fuel and lubricating oil into the soil beneath the fueling tracks. During installation of the drip slab, ballast and soil impacted with petroleum products by former fueling operations were removed from the drip slab and placed into the turntable pit.

The roundhouse was used for light maintenance of steam, and later, diesel locomotives. Operations most likely performed in this area would have included mechanical work on specific locomotive systems, welding, touch-up painting, and cleaning of locomotive parts. The turntable was used to direct locomotives to the appropriate stall for maintenance.

The Pond C area consisted of up to three, separate, holding ponds (Figure 2-2). Aerial photographs indicate that the ponds were constructed between 1938 and 1959. The ponds were used for retention of wastewater until they were decommissioned some time between 1965 and 1978. Soil excavated from the former Pond C area during closure was placed in the former turntable foundation.

The car repair shed was used for light maintenance of railcars. Operations performed in the car repair shed likely included minor welding, touch-up painting, bearing replacement, and greasing. These activities generally do not generate significant amounts of wastewater or waste that would impact soil or ground water beneath the site.

A more detailed discussion of facility operations at the Yard is provided in the *Remedial Investigation/Feasibility Study Workplan* (IC, 1993).

2.1.4 Geology

The soil at the Yard has been characterized based on the results from the cone penetrometer testing (CPT) survey, soil borehole drilling, and soil physical testing results obtained during the Phase I and Phase II RI field investigations. Geologic cross sections developed from boring log and CPT information are included in the Final RI Report. The Final RI Report includes CPT, soil borehole, and monitoring well completion logs.

The geology beneath the Yard has been observed via 72 soil borings, drilled to depths of 6.5 to 31 feet below ground surface (bgs), and 25 CPT points, completed to depths of 7.8 to 34.3 feet bgs. Based on the borehole data, the shallow geology beneath the Yard has been divided into four units, each with a unique lithologic character. These units include a surface soil unit, a silt/clay unit, a discontinuous sand unit, and an underlying dense sandy silt unit. Each of these units is described in detail below.

Surface Soil Unit

The surface soil at the Yard is composed of either native sandy clay or an imported fill material. The sandy clay is usually moist and typically dark brown. The native sandy clay is found across the Yard; however, fill material overlies the sandy clay in several developed areas, including the former drip slab, roundhouse, the holding ponds, and downslope of the holding pond area. The fill material is composed of variable mixtures of coarse, granular soil, including railroad ballast composed of red-brown volcanic rock (scoria). Bricks and other debris are occasionally found within this material. The sandy clay and fill material extend to depths of approximately 3 to 4 feet bgs, with the fill material increasing in thickness to the north (downslope).

Silt/Clay Unit

Underlying the surface soil is a silt/clay unit. This unit is encountered from approximately 3 to 4 feet bgs (beneath the surface soil), and extends to approximately 20 to 25 feet bgs. This unit ranges from silty clay/clayey silt to a sandy silt/clay.

The silt/clay unit is generally olive gray in color; however, discolored intervals are dark gray to black near the upper contact with the surface soil. The unit is generally medium stiff, moist to wet, and contains occasional thin, typically saturated, stringers of sand and fine gravel (typically less than 5 inches thick) that appear to be laterally discontinuous. At locations where the discontinuous sand unit (described below) is encountered, the silt/clay unit typically grades to a sandy clay/sandy silt material at the interface of the two units.

Discontinuous Sand Unit

The discontinuous sand unit has been encountered within the silt/clay unit described above. This sand unit varies from olive to yellowish brown, consists of sand to silty and clayey sand, is typically saturated, and is discontinuous beneath the site. This unit is typically saturated and encountered at approximately 10 to 15 feet bgs, and is generally 1 to 5 feet thick, although it appears to be thicker in the eastern section of the Yard. This unit was encountered at shallower depths (less than 10 feet bgs) in the southern portion of the Yard.

Dense Sandy Silt Unit

A very dense-to-hard sandy silt is encountered at approximately 18 to 30 feet bgs, and beneath the silt/clay and sand units described above. This material is a tan to dark brown, moderately to poorly indurated, partially or completely cemented silt to siltstone. The material is commonly fractured with iron oxide staining present along fracture planes. Where encountered, this material was dry. Only the top 1 to 2 feet of this unit was observed during the RI fieldwork. However, the log for a commercial well located approximately 200 feet south of the Yard, indicates a gray siltstone was encountered from 14 to total depth at 499 feet bgs. Granite bedrock was encountered at total depth.

2.1.5 *Hydrogeology*

Four monitoring wells (MW-K08, MW-M03, MW-N08, and MW-P07) were installed at the Yard in March 1994 during the Phase I investigation, and two monitoring wells (MW-K05 and MW-V03) and one piezometer (PZ-K05) were installed at the Yard in May 1996 during the Phase II investigation. The shallow hydrogeologic conditions beneath the Yard were characterized during the RI based on observations made during borehole drilling, water level monitoring, and field testing of hydraulic conductivity. Occurrence, local flow and gradient, and hydraulic properties associated with the ground water beneath the Yard are summarized below.

Ground Water Occurrence

First ground water is typically encountered beneath the Yard within the silt/clay unit, and/or the discontinuous sand unit, at depths between approximately 6 and 20 feet bgs. In the silt/clay unit, ground water generally occurs within the sandy silt sediments and the sand stringers. The silty or clayey sediments observed between the sandy silt sediments and wet sand stringers were observed to range from dry to wet. The discontinuous sand unit was observed to be fully saturated. The dense sandy silt unit (weathered bedrock) underlying both of these units was dry.

The shallow water-bearing formation beneath the Yard has been interpreted to extend from the first encountered saturated sediments, as discussed above, to the top of the dense sandy silt unit. Water levels measured in the six monitoring wells were observed to rise up to 4 feet above the level of first encountered ground water after installation, which may suggest semi-confined to confined hydrogeological conditions.

A localized perched ground water zone has also been defined in the area of the former drip slab foundation, in the vicinity of recovery wells RW-001 through RW-007. This perched zone is within the top 3 to 4 feet of ballast/fill material in this area. Sediments between the perched ground water and the shallow water-bearing formation ranged from dry to moist. Piezometer PZ-K05 was installed within the perched zone to assess potentiometric head data in this area. The water level elevation measured in PZ-K05 was approximately 1.69 feet higher in elevation than in the monitoring well (MW-K05), located approximately 10 feet from the piezometer when measured on 11 August 1996. This elevation difference confirmed the presence of a localized, perched ground water zone in the vicinity of PZ-K05.

Local Ground Water Flow and Gradient

Ground water contour maps prepared for each elevation-monitoring event indicate ground water flow at the site is consistently to the northeast under an average hydraulic gradient of 0.05 foot/foot.

Estimates of Hydraulic Properties and Ground Water Velocities

Hydraulic properties, such as horizontal and vertical hydraulic conductivity (K) and permeability, were estimated using field test results and published empirical methods, and documented in the Final RI Report. Depending on the test used and evaluation method applied, hydraulic properties were estimated as follows:

- Horizontal K: 0.05 to 0.45 foot/day based on slug test results evaluated using the Bouwer and Rice method (Bower and Rice, 1976);
- Horizontal K: 0.07 to 1.63 feet/day based on slug test results evaluated using the Cooper et al. method (Cooper, et al., 1967);
- Horizontal hydraulic coefficients of soil permeability (geometric mean): 5.4×10^{-4} to 1.4×10^{-3} feet/day based on pore dissipation test data collected during the CPT investigation; and
- Vertical K: 1.6×10^{-5} to 2.7×10^{-1} feet/day for saturated soil intervals as analyzed by the American Society for Testing and Materials.

Estimates of average linear ground water velocities (seepage velocities) were calculated as described in the Final RI Report and are presented below:

- Average seepage velocity using hydraulic conductivity calculated during slug testing is 0.03 foot/day; and
- Seepage velocity using the geometric mean of the horizontal coefficient of conductivity data derived from the pore pressure dissipation tests is 1.4×10^{-4} feet/day.

2.1.6 *Surface Water Hydrology*

The existing surface water drainage and ponds at the Yard are shown on all site figures. One natural pond is present in the central region of the Yard. Two man-made ponds, Pond A and Pond B, are north of the former drip slab foundation and oil/water separator (discussed below). There are two areas of active drainage at the Yard, the drainage along the eastern boundary of the Yard and that along the southwest boundary of the Yard. These drainage areas appear to run seasonally as storm water runoff.

Several creeks and areas of surface water drainage originate in the foothills to the south, and flow generally northward to Bear Creek, a tributary to the Rogue River. None of these creeks traverse the Yard property.

2.2 *PREVIOUS REMOVAL ACTIONS*

During installation of the former drip slab at the Yard (mid-1980s), ballast and soil impacted by former fueling operations were removed to the top of a perched ground water zone, which was encountered at 3.5 feet bgs. Nine passive product recovery wells were installed downgradient of the drip slab to remove floating product from the perched ground water zone. An oil/water separator and two holding ponds (Ponds A and B) were also installed at the same time as the drip slab. The oil/water separator was used to remove oil from the wastewater resulting from locomotive fueling and service operations in the drip slab area, and to treat the water recovered from the product recovery wells.

The oil/water separator consists of a settling tank equipped with a belt skimmer for removing oil. Recovered oil was pumped to an AST. The treated water was then discharged to the larger of the two ponds (Pond A) constructed of bermed earth and clay. A second pond (Pond B), which is usually dry, was used for containment of overflow from Pond A. Because floating product is no longer present in the product recovery wells, neither the product recovery wells nor the oil/water separator are currently operating.

2.3 SOURCE, NATURE, AND EXTENT OF IMPACTS

This section describes the source, nature, and extent of impacted soil and ground water at the Yard, and is based on results of the following soil and ground water investigations:

- Phase I and Phase II Environmental Site Assessments involving limited soil and ground water investigations conducted on a 2-acre portion of the Yard east of the drip slab (EMCON Northwest, Inc. [EMCON], 1992), and on the oil/water separator and associated ponds (EMCON, 1996).
- An extensive soil, ground water, surface water, and sediment investigation conducted in the LMSA during the Phase I RI (IC, 1994) including:
  - Collection of 29 shallow soil samples (up to 5.5 feet bgs) and four deep soil samples (up to 15.0 feet bgs);
  - Advancement of 17 CPT direct-push points for assessment of soil lithology, ground water occurrence, and hydrogeologic properties;
  - Installation and sampling of four ground water monitoring wells (MW-K08, MW-M03, MW-P07, and MW-N08);
  - Collection of HydroPunch ground water samples at 19 locations; and
  - Collection of surface water and sediment samples from Ponds A and B.
- Phase II RI involving extensive soil, ground water, sediment, surface water, and free product sampling, and slug testing, as discussed in the Final RI Report. The Phase II investigation included:
  - Advancement of eight CPT direct-push points for assessment of soil lithology and ground water occurrence in the area of the former car repair shed;
  - Advancement and sampling of two soil borings that were subsequently completed as monitoring wells - one upgradient of the former car repair shed (MW-V03) and one in the LMSA (MW-K05);
  - Installation of one piezometer (PZ-K05) in the LMSA;
  - Advancement and sampling of 22 soil borings, including four in the LMSA, eight in the former car repair shed area, and 10 in the off-property area;

- Collection and analysis of 26 surface soil samples (less than 2 inches bgs) within the former car repair shed area, the off-property area, and the LMSA;
- Collection and analysis of seven shallow soil samples (1 to 2 feet bgs) in the LMSA;
- Collection and analysis of 23 HydroPunch ground water samples within the former car repair shed area, the off-property area, and the LMSA;
- Collection and analysis of two sediment samples from Pond B, two sediment samples from the natural pond, and two surface water samples from the natural pond;
- Excavation of 14 shallow free product test pits and installation of five free product observation probes in the LMSA;
- Collection and analysis of a free product sample at recovery well 6 (RW-006); and
- Conducting falling and rising head slug tests at all monitoring wells.

- Quarterly ground water sampling conducted through March 1998. Results from ground water monitoring conducted prior to June 1997 are included in the Final RI Report, and results from ground water monitoring conducted from June 1997 through March 1998 are included in the *Ground Water Data Summary Report (1997 – 1998)* (ERM, 2000).

The locations of the above-mentioned sampling points are shown on the Figures A-1 through A-6 included in Appendix A, and in the Final RI Report. The results of the above-listed activities are documented in the *Phase II Environmental Assessment, Bonneville Power Administration, Proposed Ashland Substation, Ashland, Oregon* (EMCON, 1992); *Draft Phase I Remedial Investigation Letter Report* (IC, 1994); *Phase I Environmental Site Assessment – Southern Pacific Transportation Company Site* (EMCON, 1996); and the Final RI Report.

2.3.1 *Sources of Environmental Impacts*

Sources of environmental impacts at the Yard may be attributed to:

- Locomotive fueling and fuel storage (both Bunker C and diesel);
- Light locomotive maintenance and light car repair, which may have included limited use of paints and solvents;

- Waste disposal;
- Wastewater retention; and
- Potential historical application of lead arsenate pesticides at the Yard prior to rail yard activities.

2.3.2 *Nature of Environmental Impacts*

Based on the probable sources of contamination and the findings of the previous site investigations, the constituents of concern (COCs) at the Yard consist of:

- Inorganic lead and arsenic in soil;
- Longer carbon chain petroleum hydrocarbons, such as those associated with heavier fuels in soil, and in limited areas of ground water; and
- PAHs in soil (associated with heavy fuels and treated wood used for railroad ties).

2.3.3 *Risk Assessment*

Human health and ecological risk assessments were performed as part of the RI and are included in Section 5 of the Final RI Report. Following is a summary of the risk assessment findings.

Human Health Risk Assessment

Based on the results of the human health risk assessment performed as part of the RI, the concentrations of COCs in soil, sediment, surface water, and ground water at the Yard, ODEQ risk-based standards are exceeded for benzo(a)pyrene and arsenic in soil. Results of the risk assessment are summarized below.

Potential pathways for human exposure to the identified COCs detected in soil, sediment, ground water, and surface water were evaluated. The exposure assessment identified inhalation and ingestion of affected soils, as well as skin contact, as exposure pathways of potential concern. Due to the fact that chemical impacts to soil can vary widely in concentration across the Yard, which can contribute significantly to overall site risk, the Yard was divided into four exposure areas (Western, Central, Eastern, and Buffer Zone Exposure Areas). Exposure pathways for soil were developed based on the use of the Yard as commercial/industrial property, with the exception of the Buffer Zone Exposure Area, where residential exposure pathways were developed in accordance with ODEQ requirements.

Current potential receptors were considered to be a child trespasser and an industrial worker. Future potential receptors were considered to be a future construction worker and a future industrial worker for the Western, Central, and Eastern Exposure Areas, and a future resident adult and future resident child for the Buffer Zone Exposure Area.

The noncancer risks and theoretical lifetime cancer risks associated with exposure to chemicals in soil were conservatively assessed using United States Environmental Protection Agency (USEPA) reference doses and slope factors. Under current site conditions, the sum of hazard quotients (hazard index) calculated for the child trespasser and industrial worker exposed to surface soil in the Western, Central, and Eastern Exposure Areas did not exceed one, indicating that ingestion and inhalation of surface soil, as well as skin contact, would not result in noncancer adverse health effects. Also, the added lifetime cancer risks calculated for the child trespasser are well below the 1×10^{-5} (1 in 100,000) combined, maximum, lifetime cancer risk specified by the ODEQ for persons exposed to multiple potential carcinogens. Calculated added lifetime cancer risks for the industrial worker exposed to surface soil within the Western, Central, and Eastern Exposure Areas were also below the ODEQ acceptable limit of 1×10^{-5}. Only industrial worker exposure to benzo(a)pyrene in Western Exposure Area surface soil exceeded a lifetime cancer risk of 1×10^{-6}. The risk associated with benzo(a)pyrene was 2×10^{-6}.

Hypothetical future site conditions were assessed assuming exposure to surface and subsurface soil at the Yard (0 to 10 feet bgs). Hazard indices were calculated for future construction and industrial workers within the Western, Central, and Eastern Exposure Areas, and for a future residential child within the Buffer Zone Exposure Area. All calculated hazard indices were less than one, indicating that the future construction worker, future industrial worker, and residential child would be unlikely to experience noncancer adverse health affects as a result of exposure to COCs in soil at the Yard.

Combined theoretical lifetime cancer risks calculated for the future construction worker within the Western, Central, and Eastern Exposure Areas were less than a lifetime cancer risk of 1×10^{-6}. For a future industrial worker within the Western and Eastern Exposure Areas, the combined cancer risks associated with ingestion, dermal, and inhalation exposure to benzo(a)pyrene in soil were 2×10^{-6} for both areas. No other chemical exceeded a lifetime cancer risk of 1 x 10^{-6} in any of the three exposure areas. Calculated lifetime cancer risks associated with residential exposure to Buffer Zone Exposure Area soil exceeded 1 x 10^{-6} for arsenic.

The methods described above to calculate intakes and subsequently calculate hazard indices were applied to evaluate the potential risks associated with the COCs at the Yard with two exceptions: lead and TPH. Risks associated with lead exposure were evaluated by comparing lead levels at the site to Maximum Allowable Soil Cleanup Levels established in the *Soil Cleanup Manual*, ODEQ Waste Management and Cleanup Division (ODEQ, 1994). Risks associated with exposure to petroleum hydrocarbon mixtures were assessed using methods developed by the Massachusetts Department of Environmental Protection as described in Appendix C of the ERM submittal to ODEQ dated 29 May 1998 (ERM, 1998).

Ecological Risk Assessment

The ecological screening assessment of the Yard consisted of a survey by the Oregon Natural Heritage Program (ONHP) for rare, threatened, and endangered species, and comparisons of concentrations of chemicals detected in surface water and sediment to ecological preliminary remediation goals (PRGs). Although three animal species and one plant species listed by the ONHP as rare, threatened, or endangered are present within a 2-mile radius of the Yard, the locations of these species are not on or adjacent to the Yard. The Yard is not known to serve as a habitat for any of these rare, threatened, or endangered species. The reported locations in which these species occur are unlikely to be affected by chemicals detected in soil, sediment, ground water, or surface water at the Yard (ERM, 1999).

Two of the three ponds at the Yard are fenced, limiting access to the standing water in the ponds. Chemical concentrations in surface water and sediment from Ponds A and B and the natural pond were compared to ecological screening criteria. No ecological screening criterion was exceeded for surface water in the natural pond. Petroleum hydrocarbon concentrations in Ponds A and B exceeded the 1 milligram per liter criterion established by the ODEQ for surface water. Single detections of lead and selenium in surface water in Ponds A and B also slightly exceeded federal ambient water quality criteria.

Average concentrations of chemicals detected in natural pond sediment samples were at or below ecological screening criteria. The maximum concentration of lead detected in natural pond sediment samples (160 mg/kg) was greater than the ecological screening criterion (110 mg/kg). No other constituent concentrations in natural pond sediment samples exceeded ecological screening criteria.

With the exception of acenaphthene and fluorine, the average detected values of chemicals present in Pond A and B sediments were below the ecological screening criterion. The average concentrations of acenaphthene and fluorene detected in sediment samples were less than two times the ecological screening criterion. Maximum concentrations of acenaphthene, anthracene, fluorene, and arsenic exceeded ecological screening criteria in several Pond A and B sediment samples.

2.3.4 *Risk-Based Concentrations for Constituents of Concern in Soil*

As part of the risk assessments described above, risk-based concentrations were developed for soil considering current site uses as well as future potential use of the site under a residential setting (Table 2-1). However, instead of using site-specific, risk-based concentrations for lead and arsenic, the following values were used:

- The levels for lead are the Residential Maximum Allowable Soil Cleanup Levels established in the Soil Cleanup Manual (ODEQ, 1994); and
- The levels for arsenic are based on the established background concentration.

Residential use of ground water was not evaluated since there is no identified beneficial use of the shallow aquifer and there is no evidence of off-site migration of COCs in ground water.

2.3.5 *Extent of Impacts Relative to Risk-Based Concentrations*

The extent of COCs in soil and ground water has been detailed in prior investigation reports and is compiled in the Final RI Report (ERM, 1999). The extent of COCs in soil relative to risk-based concentrations for the residential exposure scenario can be summarized as follows:

- Total petroleum hydrocarbons (TPH) detections in soil exceed residential concentrations within the LMSA, Ponds A and B, and the Former Car Repair Shed Area to a maximum depth of 6 feet bgs.

- PAHs exceed residential concentrations in surface soils (0 to 0.25 feet bgs) within the LMSA and the Former Car Repair Shed Area. PAHs were also detected above residential concentrations at a depth of 5.5 feet bgs at soil boring SSB-K07.5. The most prevalent and elevated PAHs are benzo(a)anthracene, benzo(a)pyrene, and dibenzo(a,h)-anthracene (Table 2-3).
- Arsenic and lead exceed residential concentrations in shallow soils (0 to 2.5 feet bgs) within the LMSA, Pond B, and the Former Car Repair Shed Area. Lead exceeding residential levels was detected in many surface soil samples (0 to 0.5 feet bgs) collected throughout the Yard. (Table 2-4).
- Bunker C has been observed in observation test pits advanced near grid nodes L07, L08, M07, and M08. In general, the vertical extent of Bunker C in this area was 3 feet bgs. The approximate lateral extent of Bunker C in this area encompasses approximately 3,600 square feet.

Figure 2-3 shows areas at the Yard where one or more COCs exceed residential risk-based concentrations in soil. Areas exceeding residential concentrations are outlined with a blue line. Depths where goals are exceeded are also included in the figure, and isolated, single point exceedances are shown by a blue dot.

The extent of COCs in ground water can be summarized as follows:

- Heavy TPH (> C_{14}) has been detected in ground water at the LMSA, and light TPH (C_6 to C_{14}) has been detected in the Former Car Repair Shed Area. Concentrations of TPH in ground water at the site have been decreasing over time, and concentrations of TPH in upgradient monitoring wells are similar to those in on-site monitoring wells (Table 2-5).
- Volatile organic compounds (VOCs) have not been detected in ground water monitoring wells at concentrations exceeding federal maximum contaminant levels (MCLs). Benzene was detected above the MCL in one screening sample (H-V04) collected at the Former Car Repair Shed Area using a HydroPunch. Benzene was not detected in the other screening samples collected in this area (Figure A-1, Appendix A), nor has it ever been detected in MW-V03, located upgradient of the Former Car Repair Shed (Table 2-6).
- The fuel oxygenate methyl tert-butyl ether has been detected in MW-V03, a well installed in 1996 to monitor ground water originating from an off-site upgradient source. Concentrations have fluctuated between 1,100 and 2,400 micrograms per liter (μg/L) over time (Table 2-6).

These concentrations exceed the USEPA Region 9 PRG for tap water of 20 µg/L.

- PAHs have been detected sporadically in ground water monitoring wells, with the highest concentrations detected in recovery well RW-006. Of the nine PAHs detected, only benzo(a)pyrene has an established MCL of 0.2 µg/L, which has not been exceeded at the Yard (Table 2-7).
- Total chromium and total lead have been detected at concentrations exceeding federal MCLs in two monitoring wells at the LMSA. In addition, total chromium, total lead, total arsenic, and total mercury were detected in five screening samples collected from HydroPunch borings at the LMSA and the Former Car Repair Shed Area (Table 2-8). In addition, samples submitted for total metals analysis were also filtered in the field and submitted for dissolved metals analysis, to obtain data for an effective comparison of metals concentrations to MCLs. None of the detected levels of dissolved metals exceeded federal MCLs.
- Bunker C was observed during installation of piezometer PZ-K05 at 3 to 4 feet bgs; however, the presence of Bunker C was not detected during subsequent monitoring of this piezometer.

Although constituents have been detected in ground water, they are not considered to be of concern because shallow groundwater at the site has no known beneficial use and there is no evidence that constituents are migrating off site. Ground water for beneficial use in the site vicinity is drawn from a significantly deeper aquifer. There is no current or anticipated future use of shallow ground water at or in the vicinity of the Yard.

2.4 *BENEFICIAL USE SURVEY*

This section summarizes the results of the Phase II beneficial use survey, originally included in the Final RI Report (ERM, 1999).

2.4.1 *Locality of the Facility*

Oregon regulations use "locality of the facility" to define the extent of facility-related hazardous substances, considering chemical and physical properties of COCs, migration pathways, natural and human activities affecting migration of COCs, biological processes affecting bioaccumulation of COCs, and the rate at which COCs migrate under these conditions. Based on the soil and ground water data collected during the various phases of RI, the locality of the facility is confined to within the property boundary. No off-site impacts have been identified.

2.4.2 Ground Water

A well survey conducted for the Yard identified two domestic wells, two irrigation wells, one commercial well, and one unknown well within a ½-mile radius of the LMSA. Water drawn from these wells originates from depths greater than 60 to 100 feet bgs. The likelihood that COCs (Bunker C and diesel) will migrate to off-site supply wells and affect current and/or future, reasonably likely beneficial use is minimal based on the following factors:

- The viscous properties of Bunker C limit its mobility;
- The vertical separation between the shallow ground water zone at the Yard and the aquifer utilized for beneficial use is at least 40 to 60 feet, of which, 20 to 40 feet is bedrock; and
- Cross-contamination of the deeper aquifer by the future installation of a well or borehole through contaminated shallow soil or shallow ground water is minimized through the use of the State of Oregon well construction standards (Oregon Administrative Rule [OAR] 690 - Division 210).

Based on information from the City of Ashland's Department of Community Development, future land use in this area will continue to be devoted to employment, commercial, medical, and mixed-use residential uses. In addition, future property owners in this area are not likely to install new wells because new developments would be required to hook up to City water lines.

2.4.3 Surface Water

On- and off-site beneficial uses of surface water are summarized below.

On-Site Surface Water

The natural pond is designated as wetlands with beneficial uses that include the capacity to maintain aquatic life. Ponds A and B are man-made for wastewater treatment and have no current or future reasonably beneficial use. Areas of surface water drainage at the site exist on the eastern and southeastern edges of the Yard. This drainage appears to run only in response to storm water or other discharge from areas south of the site.

Off-Site Surface Water

One irrigation canal was identified within the survey area. The intake to the canal is approximately ½-mile north of the Yard near the intersection of Bear Creek and Oak Street. In addition to irrigation, likely future beneficial uses of Bear Creek include industrial water supply and livestock watering.

2.4.4 *Land*

The City of Ashland supplied current and future land use data for the Ashland Yard and surrounding area. Since completion of the RI, the Yard and some surrounding areas have been rezoned. Current zoning is provided on Figure 2-1, and summarized as follows:

- The Yard and the adjacent property to the south and west are zoned as employment district (E-1) with residential overlay.
- The land further south and west of the Yard is zoned as residential district (R-2).
- The adjacent area to the north of the Yard is zoned as an employment district (E-1). The area north of the E-1 zoning and approximately 250 feet north of the Yard is zoned E-1 with residential overlay.
- The area approximately 200 feet north of the northeast end of the Yard is zoned as a multi-family residential district (R-2). The area approximately 100 to 150 feet north of this R-2 zone is zoned as a suburban residential district (R1-3.5).
- The land to the east is zoned as a single-family residential district (R-1-5).

The permitted uses for the zoned districts are described in the Final RI Report. Uses for land zoned E-1 with residential overlay include commercial use (i.e., retail, entertainment, offices) of at least 65 percent of first-floor space. Residential use is restricted to less than 15 units per acre, with residential use permitted on the second floor space, and on no more than 35 percent of the first floor space. No parks, other than the park presently at the corner of 6th and A Streets, are planned to be developed in the vicinity of the Yard. Finally, there are no known structures protected at the Yard, and there are no current conditional or non-confining uses existing within 350 feet of the Yard boundaries.

Following the rezoning of the Yard to E-1 with residential overlay, the Yard was partitioned into seven sale parcels effective 26 May 2000, as detailed on Figure 2-4. According to UPRR Real Estate Department, two of the parcels (Parcels 1 and 2) have been sold. The sale of Parcels 3 through 6 is pending. Parcel 7 includes the former active portion of the Yard, which is the subject of the RI/FS work, and the 100-foot-wide, railroad right-of-way easement along the southern property border. As a condition of the partitioning, the City of Ashland restricted further development or land division of Parcel 7 until the property has been cleaned to residential standards, with written compliance provided by ODEQ.

2.5 *EXTENT OF IMPACT RELATIVE TO A COMMERCIAL/RESIDENTIAL MIXED LAND USE SCENARIO*

Oregon's Cleanup Law requires cleanup levels for properties that are protective of current and future likely use. Sites proposed for unrestricted multiple use are generally remediated to residential standards, which are the most restrictive. Areas proposed for commercial or industrial use are generally remediated to less stringent standards. Deed restrictions can be placed on industrial or commercial property to prevent future residential use, thereby enabling use of the less restrictive cleanup standards.

In most cases, the cleanup standards are based on site-specific risk assessments for the various pertinent exposure scenarios. However, Oregon's Cleanup Rules also contain risk-based standards applicable to all sites within the State, and can be used in lieu of a site-specific risk assessment. These Soil Cleanup Standards (OAR 340-122-045) contain specific rules for applicability and use. The risk-based concentrations presented in Table 2-1 represent the soil cleanup goals that must be achieved to make the property suitable for future commercial/residential mixed land use.

Figure 2-3 illustrates areas throughout the Yard that exceed industrial and residential cleanup goals (shown in pink and blue, respectively). The specific constituents (or constituent groups) that exceed the cleanup goals and the respective associated depths are also shown of Figure 2-3. Several of the areas where these goals are exceeded are based on one soil sample point, which is depicted on Figure 2-3 as a colored dot. These areas were denoted as a point because surrounding borings were not above cleanup goals, making it difficult to estimate the extent of cleanup goal exceedences. For the purpose of estimating costs (Section 5), it was assumed that the lateral extent of each single point exceedence encompassed a 10-by-10-foot surface area. The actual extent of impact at these points will be determined in the field during remedial activities. At areas where the extent of remedial action is based on more than one point, the estimated extent of exceedences is outlined in either blue or pink on Figure 2-3.

Based on the information presented on Figure 2-3, COCs exceeding the respective residential cleanup goals are present in approximately 5,600 cubic yards of soil.

2.6 *HOT-SPOT EVALUATION*

ODEQ requires that all remedies considered in an FS address treatment of "hot spots." According to the *Final Guidance for Identification of Hot Spots* (ODEQ, 1998b), a hot spot in a media other than water exists if "the site presents an unacceptable risk and if the contamination is highly concentrated, highly mobile or cannot be reliably contained." Hot spots are not a concern at the Yard because a comparison between site analytical data and values in the *Final Pre-Calculated Hot Spot Look-Up Tables* (ODEQ, 1998c) resulted in no exceedences of hot spot levels. In addition, the constituents present in the site soils are not reasonably likely to migrate and are reliably contained.

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3.0 *IDENTIFICATION OF REMEDIAL ACTION OBJECTIVES*

Based on results of the site investigation (ERM, 1999), and the risk assessment (summarized in Section 2.3.3), and with consideration of the current zoning of the site as mixed commercial/residential, the following remedial action objectives have been identified:

- Prevent human exposure (via ingestion or inhalation) to soil that exceeds the residential cleanup goals (Table 2-1);
- Remove surface features associated with former Yard operations;
- Prevent human exposure to the Bunker C/TPH impacts in the former landfill area; and
- Quantify TPH impacts in the surface water in Ponds A and B, and remove and handle pond water appropriately.

As discussed in Section 2.6, there are no areas at the Yard that can be classified as hot spots as defined in OAR 340-122-115(31)(b). Therefore, the remedial action objectives do not consider the treatment of hot spots.

3.1 *AREAS REQUIRING REMEDIAL ACTION*

As depicted on Figure 2-3, areas of concern at the Yard that require remedial action are summarized as follows:

- Soils from 0 to 2 feet bgs in the LMSA and Former Car Repair Shed that contain lead and/or arsenic at concentrations above residential cleanup goals;
- Soils from 0 to 5 feet bgs in the area north of Pond A and surface soils in the Former Car Repair Shed that contain one or more PAH compounds exceeding residential cleanup goals.
- Surface soils near the former Drip Slab, and north of both Pond A and the former round house containing one or more PAH compounds exceeding the residential cleanup goals (based on single-point exceedences rather than widespread detections);
- Soils within the 5-foot range north of Pond A that contain TPH above the residential cleanup goal; and

- Soils within the 5-foot range adjacent to and beneath the former Drip Slab that contain TPH above the residential cleanup goal.

Features associated with former rail yard operations that require removal and/or remedial action include the following:

- The oil/water separator, underlying affected soils, and the tank saddles;
- Ponds A and B;
- The Bunker C area within the former land fill;
- Ballast and residual petroleum near the former Drip Slab Foundation; and
- Oil collection culverts and recovery wells, piezometers, free product observation probes, and monitoring wells.

4.0 REMEDIAL ACTION ALTERNATIVES

Remedial action alternatives were developed by initially reviewing four general response action categories:

- No Action;
- Engineering and/or institutional controls;
- Treatment; and
- Excavation and off-site disposal without treatment.

Remedial technologies associated with each general response action category were then evaluated and screened to address the remedial action objectives at the site. Finally, those technologies that screened favorably were used to develop five remedial action alternatives.

4.1 GENERAL RESPONSE ACTIONS

General response actions are actions that will satisfy the remedial action objectives. Remedial technologies can be categorized as one of the four general response actions described below.

4.1.1 No Action

An alternative that incorporates the "No Action" response serves as a baseline for comparison of other potential remedial actions. Actions taken to reduce the potential for exposure are not included in the No Action alternative.

4.1.2 Engineering and/or Institutional Controls

Engineering controls are physical measures that prevent or minimize exposure to hazardous substances or reduce the mobility or migration of hazardous substances. In contrast, institutional controls are legal or administrative measures or actions that reduce exposure to hazardous substances.

4.1.3 *Treatment*

Treatment is the permanent and substantial elimination or reduction in the toxicity, mobility, or volume of hazardous substances with the use of in situ or ex situ remedial technologies. Treatment may occur on or off site.

4.1.4 *Excavation and Off-Site Disposal without Treatment*

Excavation and off-site disposal includes excavating impacted soil and transporting it to a permitted off-site disposal facility.

4.2 *IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES*

Several remedial technologies were evaluated based on how well they address the COCs and the remedial action objectives. These technologies are described below. Those technologies that passed the initial screen described in Section 4.3 were used in the development of a range of remedial action alternatives in Section 4.4.

4.2.1 *No Action*

This approach does not involve measures to contain or treat metals, PAHs, and hydrocarbons in site soils. This passive response would employ natural attenuation and biodegradation as the only treatment. Even though some of the contaminants at the site will attenuate and biodegrade, such processes require a substantial amount of time to reduce constituent concentrations to an acceptable level.

4.2.2 *Engineering and/or Institutional Controls*

Asphalt or Concrete Cap

An engineered asphalt or concrete cap is an engineering control that consists of covering impacted areas with a layer of asphalt or concrete to eliminate direct exposure to impacted surface soils, and prevent potential downward migration of surface and subsurface contaminants due to surface water infiltration. As stated above, sites employing this type of control would remain on ODEQ's inventory of sites requiring further action.

Soil or Gravel Cap

An engineered soil or gravel cap consists of covering impacted areas with a layer of gravel or clean soil to eliminate windblown dust and direct exposure to impacted surface soils. The thickness of the cap and the type of material (i.e., gravel or soil planted with grass) could vary depending on how the area to be capped is to be developed. As stated above, sites employing this type of control would remain on ODEQ's inventory of sites requiring further action.

Land Use Restriction

A land use restriction is an institutional control that would limit future land use through a deed restriction. A deed restriction would reduce exposure to COCs by limiting future use of the site. Sites employing this type of control will remain on ODEQ's inventory of sites requiring further action.

4.2.3 *Treatment*

Treatment technologies are typically discussed as either in situ, occurring in place, or ex situ, where soils are first excavated then treated on or off site.

4.2.3.1 *In Situ Bioremediation*

In situ bioremediation can be used to remediate soils impacted with organic compounds, including heavy hydrocarbons and PAHs. This technology is most successful when naturally occurring soil microbes, capable of degrading the organic compounds, are well distributed throughout the affected soil. In situ biodegradation involves enhancing the degradation of organic compounds by encouraging natural microbial activity through the addition of oxygen. Oxygen can be circulated through the subsurface using a series of vapor extraction and ventilation wells. This technology is not as effective in low permeability soils due to its inability to deliver the amount of oxygen necessary to treat this type of soil. In situ bioremediation is a proven method for treating TPH- and PAH-affected soils, although it is often not effective at treating metals in soil.

4.2.3.2 *In Situ Phytoremediation*

Phytoremediation uses living plants for remediation of impacted soil, sludges, sediments, and ground water by removing, degrading, or stabilizing the COCs. Phytoremediation can be used to remediate various substances, including metals, pesticides, solvents, explosives, petroleum hydrocarbons, PAHs, and landfill leachates. In the following paragraphs, two phytoremediation processes are assessed for the removal and/or degradation of constituents found at the Yard, including arsenic, lead, PAHs, and heavy hydrocarbons.

Phytoextraction

Phytoextraction can be utilized to remediate shallow, metals-impacted soils (less than 18 inches bgs) through the use of plants, such as Indian mustard, that accumulate metals into the harvestable, above-ground portion of the plant. To effectively employ phytoextraction, the plant used must grow vigorously (creating greater than 3 tons dry matter/acre-year), have an easily harvestable aboveground portion, and accumulate large amounts of metals (greater than 1,000 milligrams per kilogram) in aboveground biomass. Generally, arsenic is relatively bioavailable, while lead is not easily translocated to the harvestable mass. However, it has been shown that the addition of ethylenediaminetetraacetic acid (EDTA) to the soil greatly enhances the solubility and bioavailability of lead.

Rhizosphere Biodegradation

Rhizosphere biodegradation can be utilized to remediate soils impacted with organic compounds, such as PAHs and heavy hydrocarbons. These compounds are broken down into harmless byproducts through microbial activity that is enhanced within the rhizosphere (soil profile in close contact with the roots of plants). The degradation of organic compounds is enhanced by natural substances released by plant roots (such as sugars, alcohols, and acids) that act as nutrient sources for soil microorganisms. Rhizosphere biodegradation is also aided by plants loosening the soil and transporting oxygen and water to affected soils. Applicable plants for rhizosphere biodegradation include grasses with fibrous roots (rye, fescue, and bermuda) for depths less than 3 feet bgs, and phreatophyte trees (hybrid poplar, willow, cottonwood, and aspen) for depths less than 10 feet bgs. The length of time required to achieve remediation goals is highly variable and dependent upon constituent concentrations in the treatment zone, existing natural degradation processes, and plant growth rates.

4.2.3.3 *In Situ Soil Flushing*

In situ soil flushing consists of treating the impacted soil by injecting a non-toxic, biodegradable, extraction solution (such as water and surfactant) to "flush" the contaminants from the soil into solution, which is then extracted from the underlying ground water. The extraction solution mobilizes the contaminants in the soil by solubilizing them into solution. The ground water, along with the extraction solution and dissolved contaminants, is then extracted and treated above ground to separate the contaminants from the solution. Bench-scale tests are required to develop an extraction solution that solubilizes the COCs.

Pneumatic Fracturing

Pneumatic fracturing is a technology used to increase the effectiveness of the in situ remediation process. The technology involves injecting pressurized air beneath the surface to develop micro-fractures in low permeability sediments. The new passageways created by this technology result in an overall increase in the amount of soil available to in situ processes.

4.2.3.4 *Excavation and Ex Situ Treatment*

Excavation consists of the removal of affected soils using conventional excavation equipment. Proper shoring or sloping is required to prevent sidewall failure. Clean imported soil, or existing site soils remediated by one of the following processes, is used to backfill the excavation. The treatment processes below can be performed on or off site.

Aboveground Treatment Cell Bioremediation

Bioremediation in aboveground treatment cells is a process that treats soils by controlling moisture, heat, nutrients, and oxygen. By enclosing the soil in a treatment cell, the offgas can be collected by a vapor extraction system to prevent contaminants from escaping to the atmosphere. Ex situ bioremediation is a proven, effective method for treating hydrocarbon- and PAH-affected soils. However, soil impacted with metals is not addressed by this method.

Thermal Treatment

Thermal treatment is a process that uses heat to destroy, separate, or immobilize the contaminants. Destruction techniques, such as incineration, typically produce a solid residue (e.g., ash), and possibly a liquid residue (e.g., condensate from the air pollution control equipment) that requires treatment or disposal. Separation techniques, including thermal desorption and hot gas decontamination, use heat to volatilize the contaminants. The heat produces an offgas stream requiring treatment. Immobilization techniques, including vitrification, use heat to melt contaminants producing a slag that requires disposal. In each of the above-mentioned thermal-treatment processes, the residual requiring treatment or disposal is much smaller in volume than the original amount of soil treated. These treatment processes are effective in treating TPH- and PAH-affected soils, but are not effective in treating metals-impacted soils.

Ex Situ Soil Washing

Soil washing is a technology that uses an aqueous-based washing fluid and a mechanical process to scrub soils. This process first reduces the volume of contaminated soil by separating the silt and clay particles (to which contaminants tend to bind) from the sand and gravel particles. When completed, the fine silt and clay particles are further treated by mixing the soil with a detergent solution to remove the COCs. This mixing of the soil and wash solution is a high-energy process that ensures adequate contact between the soil and the solution. Following the detergent wash, several rinse cycles are typically required to remove the chemical and detergent from the soil. The liquid is then separated from the soil for treatment, and the clean soil is dried and placed back into the excavation along with the previously removed sand and gravel particles. Soil washing is a proven, effective method for treating hydrocarbon-, PAH-, and metals-affected soils; however, extensive time requirements for treatment, as wells as the large amount of liquid waste produced by this process that would require treatment, could render this technology cost-prohibitive.

Stabilization/Solidification

Solidification is a process where chemical reactions are induced between a stabilizing agent and contaminants. The reaction binds or encloses the contaminants within a stabilized mass. The stabilizing or solidifying agent and process is dependent on soil types and the type of contaminants present. Stabilization/solidification is a proven, effective method for treating hydrocarbon-, PAH-, and metals-affected soils. Additionally, it produces a material that can be reused on site without generating waste.

Asphalt Incorporation

Asphalt incorporation is a method of treatment combining thermal processes with stabilization/solidification. The process initially involves treatment of the soil through low-temperature thermal desorption by heating the affected soil in a rotary kiln to temperatures above the vaporization point of the hydrocarbon constituents. The treated soil can be incorporated into asphalt concrete or bituminous road base, and reused on site during development. Hydrocarbon-containing soils are suitable for asphalt incorporation because the process requires the addition of asphalt. This process may also be effective at stabilizing metals, however, bench-scale and leachate testing of the treated material are required to determine if COCs, including metals, could be effectively stabilized using this process.

Asphalt incorporation is best suited for dry, sandy, gravely soils, and becomes less effective as soil grain size decreases and/or moisture content increases. Surface soils at the site consist of a mixture of clay, sand, coarser material, and rock, and therefore, may be suitable for asphalt incorporation.

4.2.4 *Excavation and Off-Site Disposal or On-Site Encapsulation*

Excavation and off-site disposal consists of removing affected soil and transporting it off site for disposal at an approved facility. Depending on COC concentrations, some affected soils may be encapsulated on site within earthen mounds, or beneath paved roadways, parking lots, or buildings.

Excavation and Off-Site Disposal

Excavation and off-site disposal of soils at an approved landfill is a quick, effective, and proven method for remediating sites with TPH-, PAH-, and metals-affected soils. This technology is also easily implemented because it requires only conventional construction equipment (such as excavators, loaders, and dump trucks or railcars). Prior to acceptance at an approved landfill, affected soils must be tested and profiled according to individual landfill requirements. A negative aspect of landfill disposal is the potential, long-term liability of the affected soil remaining in the landfill for an indefinite period.

Excavation and On-Site Encapsulation

This technology involves excavating affected soils then encapsulating (or burying) these soils on site beneath roadways, parking lots, or other asphalt- or concrete-covered surfaces. Conversely, affected soils could be used to create a soil mound that could be capped with clean soil and vegetation. This technology significantly reduces the potential for human and ecological exposure to COCs, whether affected soils are encapsulated beneath paved surfaces or a soil cap. The use of asphalt or concrete also reduces constituent mobility to ground water. This approach is most applicable for soils affected by constituents that have a low potential to leach or migrate, such as those affected by metals and PAHs. Leachate studies are required to ensure that ground water will not be affected over the long term. Provisions, such as clean utility corridors, must me made to protect future utility workers from exposure to affected soils. Similar to the engineering controls discussed above (i.e., asphalt or soil cap), sites employing this approach remain on ODEQ's inventory of sites requiring further action.

4.3 *EVALUATION AND SELECTION OF REPRESENTATIVE TECHNOLOGIES*

Several technologies were retained for further application in the development of remedial action alternatives based on considerations related to efficacy, implementability, and cost. These include No Action, a soil or gravel cap, solidification/stabilization via asphalt incorporation, excavation with on-site encapsulation, and excavation with off-site disposal.

A land use restriction to reduce exposure to COCs by limiting future use of the site was rejected because the property is currently zoned for commercial/residential mixed use. Oregon Rules require protection commensurate with the current and future beneficial use, and the land use restrictions required for the site are not compatible with residential development.

In situ bioremediation was rejected as a treatment technology for TPH and PAH constituents primarily because it would conflict with future redevelopment plans due to the considerable amount of time needed to degrade the heavier hydrocarbons and achieve the cleanup goals, especially in the low permeability soils.

In situ phytoextraction was rejected because it would likely require one or more years to achieve cleanup goals, depending on the metals concentrations in the treatment areas. If EDTA is introduced to enhance lead bioavailability, it would increase the probability of lead migration to ground water. Finally, the impacted plant matter could pose a threat to animals that feed on it. Once harvested, the metal-laden biomass would need to be disposed properly, possibly at a hazardous waste landfill.

In situ rhizosphere biodegradation was rejected primarily because it would conflict with redevelopment plans due to the considerable amount of time needed to achieve cleanup goals. Integrating this technology into site redevelopment would require that the appropriate trees are incorporated into the plans, and that institutional controls are in place to protect against exposure to affected surface soils during the remediation process.

In situ soil flushing was rejected because, although it has the potential to treat all COCs, the heterogeneity and low vertical conductivity of site soils would severely limit the migration of the extraction solution, resulting in very slow remediation rates. Additionally, obtaining hydraulic containment will be difficult. Pneumatic fracturing was rejected because it will likely not increase vertical conductivity, which is necessary to improve the effectiveness and remediation rates of in situ soil flushing.

Aboveground treatment cell bioremediation and thermal treatment were both rejected due to the inability of these technologies to remove metals, one of the primary COCs at the site. On-site thermal treatment was also rejected due to anticipated difficulties in obtaining permits and community acceptance.

Ex situ soil washing was rejected because, although it has the potential to treat all COCs, it is an energy-intensive process and would generate a large volume of wastewater that would require treatment and/or disposal.

Finally, the asphalt or concrete cap was rejected because, unless the design was incorporated into development plans, it would place severe limitations on future site redevelopment.

4.4 DEVELOPMENT OF REMEDIAL ALTERNATIVES

The technologies deemed appropriate for further consideration to address the removal action objectives for soil are described in this section, and summarized in Table 4-1. In addition, a common strategy for removing surface features associated with former Yard operations is included under each action alternative (Section 4.4.2).

4.4.1 Alternative 1 - No Action

The No Action alternative constitutes a measure in which no action is taken to reduce or remove site impacts or restrict site access. However, natural subsurface processes to reduce contaminant concentrations, such as dilution, attenuation, biodegradation, adsorption, and chemical reactions, would continue. The No Action alternative is used to establish a baseline against which the degree of remediation and associated costs of the other alternatives can be compared.

4.4.2 Common Tasks of Alternatives 2, 3, 4, and 5

In addition to the various strategies for addressing affected soils, Alternatives 2, 3, 4, and 5 have common tasks that address the surface features associated with former Yard operations, which include:

- Removal of the oil/water separator, including affected soils, and removal of the tank saddles near the oil/water separator;
- Abandoning the oil collection culverts and recovery wells, free-product observation probes, piezometer, and monitoring wells;
- Backfilling Ponds A and B;
- Excavation and off-site disposal of the Bunker C area;
- Removal of ballast and residual petroleum associated with the former Drip Slab; and
- Preparation of a site-specific health and safety plan.

Figure 4-1 shows the areas at the Yard where the tasks would occur. The tasks described above are considered to be "presumptive remedies," because there are limited options available for completing the common tasks, and because the proposed actions will most effectively satisfy the objective of removing surface features associated with former Yard operations. The common tasks are identical for all alternatives, except the

No Action alternative and, therefore, discussion regarding these tasks will be limited to the following paragraphs.

Removal of Oil/Water Separator and Tank Saddles

This task will consist of the following activities:

- Sampling and analysis of the water in the oil/water separator, draining the oil/water separator tank, then either discharging the water on site or pumping it into a tanker car or truck for off-site disposal (disposition of water depends on the levels of COCs in the water);
- Disassembling and removing the oil/water separator;
- Excavating tank saddles down to the footings, breaking them up with a hoe ram, and stockpiling;
- Excavating visibly affected soils beneath and surrounding the oil/water separator and tank saddles, then stockpiling, sampling, and characterizing the soils for disposal at an approved off-site facility;
- Verification samples of the excavation sidewalls and bottom will be collected and analyzed;
- Transporting affected soils to an approved off-site facility for disposal;
- Disposing of concrete tank saddle footings and the oil/water separator at a Class III facility; and
- Backfilling and compacting the excavations with either imported fill material or soils originating on site (as proposed in Alternatives 3, 4, and 5).

Abandonment of Wells and Culverts

Oil collection culverts and oil recovery wells, free-product observation probes, piezometers, and monitoring wells will be properly abandoned. Abandonment will be performed in compliance with ODEQ requirements, which includes:

- Obtaining the necessary permits;
- Removing oil collection culverts by excavation, then backfilling with clean soil;
- Removing other wells by overdrilling;
- Filling the resulting holes with grout or a cement slurry; and

- Disposing well materials at an approved off-site facility.

Preparation and Backfilling of Ponds A and B

The preparation and backfilling of Ponds A and B will include:

- Sampling and analysis of water in Ponds A and B, draining the ponds, then either discharging the water on site or pumping it into a tanker car or truck for off-site disposal (disposition of water depends upon the levels of COCs in the water);
- Sampling and analysis of pond bottom sediments, and sediment removal, if necessary, based on COC concentrations observed in the samples;
- Clearing and grubbing debris and vegetation from in and around the ponds and disposal of the debris at a Class III facility;
- Laying filter fabric then rock at the base of the ponds to facilitate even compaction;
- Backfilling and compacting the ponds with either imported fill material or soils originating from on site (as proposed in Alternatives 3, 4, and 5); and
- Moisture-conditioning backfill material after placement, as necessary, and compacting material to a minimum of 90 percent maximum density in accordance with recognized standards.

Excavation and Off-Site Disposal of Bunker C

The removal of the Bunker C within the former landfill area will include the following:

- Excavating Bunker C-impacted soils, stockpiling the materials on plastic sheeting, then sampling the soils for characterization and disposal;
- Transporting oily ballast and oily soils to an approved off-site facility for disposal; and
- Backfilling and compacting the excavation with either imported fill material or soils originating from on site (as proposed in Alternatives 3, 4, and 5).

Remove Ballast and Residual Petroleum Associated with the Former Drip Slab

The removal of ballast and residual petroleum associated with the former drip slab will involve:

- Excavating ballast and oily soils adjacent to former drip slab, stockpiling the materials on plastic sheeting, then sampling the soils for characterization and disposal;
- Collecting and analyzing verification samples from the excavation sidewalls and bottom;
- Transporting oily ballast and oily soils to an approved off-site facility for disposal; and
- Backfilling and compacting the excavation with either imported fill material or soils originating from on site (as proposed in Alternatives 3, 4, and 5).

Health and Safety

A site-specific health and safety plan must be prepared prior to conducting the common tasks described above, or implementing any of the action alternatives described below. At a minimum, the plan must satisfy Oregon Occupational Safety and Health Administration requirements and address the following topics:

- Chemical and physical hazards associated with the site and planned remediation activities;
- Training and medical surveillance requirements for site personnel;
- Exposure monitoring plan for site workers and action levels for personal protection;
- Levels of personal protection, including respiratory protection requirements;
- General site safety requirements; and
- Emergency and first aid procedures.

4.4.3 *Alternative 2 – Engineered Soil Cap*

Alternative 2 would include the common elements discussed above, plus the placement of a soil cap over the areas exceeding the residential cleanup goals (Figure 2-3). The engineered soil cap would consist of certified clean soil compacted to 90 percent of maximum density. The soil cap would eliminate direct exposure to impacted surface soils and reduce potential migration of surface and subsurface contaminants due to the infiltration of surface water. The installation of an engineered soil cap would include:

- Soliciting bids and hire contractor(s);
- Securing and testing cap soil to ensure that it does not contain organic or metal contaminants;
- Preparing the site (such as establishing fencing, equipment and soil staging areas, utility locations, and removing concrete in capping areas);
- Collecting and analyzing soil samples to define the surface areas to be capped, and surveying to outline impacted areas;
- Removing and disposing of trees, shrubs, debris, and other surface features from the areas to be capped;
- Applying water for dust suppression during earth work;
- Installing and compacting soil in 4- to 6-inch lifts and compacting each lift to 90 percent maximum density until soil cap is approximately 2 feet thick, with a minimum of 5 additional lateral feet beyond the defined area of impact;
- Placing and compacting 6-inch top soil layer, then planting with native grasses;
- Surveying final limits of soil cap and including this information and the surveyed limits of affected areas into the title and deed restriction documents; and
- Conducting annual inspections and performing routine maintenance to ensure cap integrity.

Should future development involve the need to uncover or remove affected soils (such as placement of a roadway, or installation of a building or structure), an environmental contractor must be hired to conduct the earthwork and handle the soils appropriately. Such activities would also require notification of the ODEQ prior to excavating or managing soils from beneath the soil cap. Similarly, should future development of the site involve the installation of a utility corridor through a capped area, an environmental contractor must do the excavation work. Utility corridors should then be backfilled with clean material, such as soil or gravel, to enable future access to buried utilities by workers.

4.4.4 *Alternative 3 – Excavation and Off-Site Disposal*

With Alternative 3, soils exceeding residential cleanup goals would be excavated and transported off site for treatment or disposal. The estimated extent of soils exceeding applicable cleanup goals is shown on Figure 2-3.

Soils would be excavated using an excavator or backhoe operated by qualified personnel. Excavated soils would be placed on plastic sheeting prior to transportation off site via truck or rail. Although existing site data will be used to guide excavation activities, confirmation soil sampling will be conducted to determine when to stop digging in each area.

Underground utilities would be located prior to digging through Underground Services Alert, a private utility locator, and UPRR Hot Line (1-800-336-9193). If active underground utilities are encountered during excavation, they will remain in place and be carefully uncovered and supported. If abandoned underground utilities are encountered, they will be cut, removed, and capped as necessary.

Implementation of this alternative would generally include:

- Soliciting bids and hiring contractor(s);
- Securing and testing backfill material;
- Preparing the site (such as establishing fencing, staging areas, stockpile areas, utility locations, and removing concrete in excavation areas);
- Surveying to define excavation areas;
- Performing excavation and stockpiling as described above;
- Collecting and analyzing soil samples from the base and sidewalls of each excavation to determine if cleanup goals have been achieved, or if additional excavation is required, and to document residual COC concentrations;
- Collecting and analyzing samples from the stockpiled soil slated for off-site treatment and/or disposal to satisfy disposal facility profile requirements;
- Transporting soils containing COCs above residential cleanup goals to an approved treatment and/or disposal facility;
- Surveying the final limits of the excavations;
- Backfilling the excavations that extend greater than 6 inches bgs with certified clean imported soil; and

- Compacting backfill to a minimum of 90 percent maximum density in accordance with recognized standards, and performing compaction testing to verify.

4.4.5 *Alternative 4 – Excavation with Asphalt Incorporation and On-Site Reuse*

With Alternative 4, soils exceeding residential cleanup goals would be excavated then incorporated into asphalt, which could be used on site in roadways and parking lots during redevelopment. Prior to implementation, bench-scale testing and leachate testing of representative soil samples would be necessary to ensure that the COCs will be stabilized in the asphalt incorporation process.

Implementation of Alternative 4 would generally include:

- Conducting bench-scale testing and leachate testing of representative soil and asphalt batch samples;
- Hiring contractors, securing backfill material, and preparing the site as described in Alternative 3;
- Excavating soils, as described in Alternative 3, and segregating soils into stockpiles;
- Surveying the final limits of the excavations;
- Mobilizing asphalt-incorporation equipment and needed materials to the site;
- Delineating and preparing areas where the treated material will be used (i.e., roadways or parking lots);
- Creating either asphalt, concrete, or bituminous road base using asphalt incorporation, as described in Section 4.2.3.4, then placing the treated material in predetermined locations; and
- Backfilling and compacting the excavations as described for Alternative 3.

4.4.6 *Alternative 5 – Excavation with Off-Site Disposal and On-Site Encapsulation*

Under Alternative 5, TPH-affected soils would be excavated and transported off site for disposal. Soils exceeding residential cleanup goals for PAHs and metals would be excavated, then either buried on site beneath asphalt or concrete, or transported off site for disposal. For cost estimation purposes, it was assumed that approximately two-thirds of the soils exceeding residential levels for metals and PAHs would be buried on site, while the remaining one-third would be transported off site with the TPH-impacted soils. The actual amounts, however, may vary.

Soils targeted for off-site disposal would be excavated first then transported off site for treatment or disposal as described in Alternative 3.

Excavated soils exceeding residential cleanup goals for metals and PAHs and targeted for on-site burial would be stockpiled on plastic sheeting, sampled, and analyzed by a certified analytical laboratory. Soil analyses would include leachate testing to ensure that the COCs remain stable once buried. Soils that have unacceptable leachate concentrations would be profiled and shipped off site for disposal.

On-site area(s) would be established for the purposes of burying the affected soils. These area(s) would include selected areas targeted for development as roadways and/or parking lots. Designated areas would be excavated to a depth less than the historical minimum depth to ground water (a depth of 3 feet bgs was used for cost estimation purposes). The resultant soils would be stockpiled, sampled, and analyzed, then used as fill.

Provisions for utility corridors must be made prior to placing the affected soils in the burial area(s) so that utilities could be accessed for expansion and/or repair without disturbing these soils.

Soils with residential goal exceedences deemed acceptable for on-site burial would be placed in the designated soil burial areas, whereas the remainder of the stockpiled soils would be used to backfill open excavations at the site. Clean fill material would be imported to satisfy the remainder of the fill needs. During backfilling, soil would be moisture-conditioned, as necessary, then compacted to a minimum of 90 percent maximum density. Following the placement and compaction of the affected soils, asphalt would be placed over the impacted soils with a 2-foot overlay on all sides. The final dimensions and locations of each soil burial area would be surveyed and documented.

Implementation of Alternative 5 would generally include:

- Hiring contractors, preparing the site, and securing fill material, if needed, as described in Alternative 3;
- Excavating soils from burial areas, stockpiling, and sampling;

- Excavating, stockpiling, and sampling TPH soils;
- Excavating and stockpiling soils exceeding residential cleanup goals for metals and PAHs, sampling and analysis including leachate analysis of soils to be buried;
- Profiling and transporting all soils targeted for off-site disposal to an approved treatment and/or disposal facility, as described in Alternative 3;
- Surveying the final limits of the excavations and the soil burial area(s);
- Placing soils in burial area, compacting as described above, and surfacing with asphalt;
- Backfilling and compacting the other excavations that extend greater than 6 inches bgs, as described for Alternative 3, using soils excavated from burial areas as fill if clean;
- Surveying final limits of asphalt cap(s) and recording this information on the deed restriction; and
- Conducting annual inspections and performing routine maintenance to verify the integrity of the asphalt cover.

The deed restriction incorporated into this alternative would require notification of the ODEQ prior to excavating and managing soils from beneath the asphalt cap.

5.0 DETAILED ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

This section presents a detailed evaluation of remedial action alternatives. First, the ODEQ evaluation criteria are described. Then, each alternative is evaluated with respect to the criteria. Finally, the alternatives are rated against each other relative to the evaluation criteria.

5.1 ASSESSMENT CRITERIA

Oregon's environmental cleanup laws require that each remedial action alternative be evaluated against the protectiveness requirement, the preference to treat hot spots, if present, and a balancing of the remedy selection factors. These assessment criteria are described below.

5.1.1 Protectiveness

Protectiveness represents the ability of the remedial action alternative to protect human health and the environment, as demonstrated through a residual risk assessment. The residual risk assessment includes:

- A quantitative assessment of the risk resulting from concentrations of untreated waste or treatment residuals remaining at the site at the conclusion of remedial action, which considers both current and likely future land and water use scenarios, and the exposure assumptions used in the baseline risk assessment;
- A qualitative or quantitative assessment of the adequacy and reliability of any institutional or engineering controls to be used for management of treatment residuals and untreated hazardous substances remaining at the site; and
- Demonstration that the combination of the above-mentioned assessments would attain acceptable levels of risk, as defined in OAR 340-122-115, in the locality of the facility.

Residual risks are typically evaluated qualitatively as part of the detailed alternatives evaluation. A quantitative residual risk assessment is required to support the recommendation for a specific remedial action alternative.

5.1.2 *Treatment of Hot Spots*

Treatment of hot spots at this site is not necessary because, as discussed in Section 2.6, no hot spots exist at the Yard.

5.1.3 *Remedy Selection Balancing Factors*

The remedial action alternatives will be assessed based on a balancing of five remedy selection factors. These balancing factors and the criteria to assess each factor are described below.

5.1.3.1 *Effectiveness*

The assessment of effectiveness determines if the remedial action alternative is able to achieve the desired level of protection to human health and the environment. The effectiveness in achieving protection is assessed by the following criteria, as appropriate:

- Magnitude of risk from untreated waste or treatment residuals remaining at the site without any risk reduction achieved through on-site management of exposure pathways;
- Ability of engineering and institutional controls to manage the risk from treatment residuals and untreated hazardous substances remaining at the site;
- Ability for treatment technologies to meet treatment objectives;
- Time required for achievement of remedial action objectives; and
- Any additional information relevant to effectiveness.

5.1.3.2 *Long-Term Reliability*

The assessment of long-term reliability determines the ability of a remedial action alternative to maintain the required level of protection after its implementation. Each remedial action alternative is assessed for long-term reliability, using the following criteria, as appropriate:

- Reliability of treatment technologies in meeting treatment objectives;
- Reliability of engineering and institutional controls necessary to manage the risk from treatment residuals and untreated hazardous substances, based on the characteristics of the hazardous substances to be managed;

- The effectiveness and enforceability over time of engineering and institutional controls in preventing migration of contaminants and in managing risks associated with potential exposure;
- The nature, degree, and certainties or uncertainties of any necessary long-term management; and
- Any other information relevant to long-term reliability.

5.1.3.3 *Implementability*

The assessment of implementability determines whether, or with how much difficulty, the remedial action alternative can be implemented and if the alternative's continued effectiveness can be assessed and verified. Each remedial action alternative is assessed for the ease or difficulty of remedial action implementation, using the following criteria, as appropriate:

- Practical, technical, and legal difficulties and unknowns associated with the construction and implementation of a technology, engineering control, or institutional control, including potential scheduling delays;
- Ability to monitor the effectiveness of the alternative;
- Consistency with federal, state, and local requirements; activities necessary for coordination with other agencies; and ability and time to obtain necessary authorization from other governmental bodies;
- Availability of necessary services, materials, equipment, and specialists; and
- Any other information relevant to implementability.

5.1.3.4 *Implementation Risk*

Implementation risk addresses the effects on human health and the environment during the construction and implementation phase. Each remedial action alternative is assessed for the potential risk associated with implementing the remedial action using the following criteria, as appropriate:

- Potential impacts on the community during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures;
- Potential impacts on workers during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures;

- Potential impacts on the environment during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures;
- Length of time until the remedial action is complete; and
- Any other information related to implementation risk.

5.1.3.5 *Reasonableness of Cost*

The assessment of reasonableness of cost ordinarily is a two-part assessment. First, the remedial action cost is estimated using standard engineering procedures. Second, the degree to which the costs are "proportionate to the benefits" is determined in a qualitative manner. The remedial action alternative is assessed for the reasonableness of cost by considering the following criteria, as appropriate:

- Cost of the remedial action including:
  - Direct and indirect capital cost;
  - Annual operation and maintenance (O&M) costs;
  - Costs of any required periodic reviews; and
  - Net present value of all of the above.
- Proportionality of remedial action costs to the benefits to human health and the environment created through risk reduction or risk management.
- Degree of sensitivity and uncertainty of the costs.
- Any other information relevant to reasonableness of cost.

5.2 *INDIVIDUAL ANALYSIS OF ALTERNATIVES*

Following presents a detailed analysis of each alternative relative to the evaluation criteria described above. In order to provide a comprehensive evaluation, the common tasks, described in Section 4.4.2, are included with the evaluation of each action alternative.

5.2.1 *Alternative 1 - No Action*

Following is an evaluation of Alternative 1 with respect to the protectiveness criterion, and the five remedy selection balancing factors (effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost).

5.2.1.1 *Protectiveness*

With the No Action alternative, no actions are taken to control exposure to COCs or remove affected soils. Because the risks associated with residual wastes are not addressed, the resulting risks to human health under a commercial/residential land use scenario would not be acceptable.

5.2.1.2 *Effectiveness*

The No Action alternative would not be effective at reducing magnitude of risk at the facility because no action would be taken to reduce or control the toxicity, mobility, and volume of COCs at the Yard. COCs such as petroleum hydrocarbon constituents can degrade naturally; however, such degradation could take a considerable amount of time. As no action is taken to treat, reduce, or remove affected soils, this alternative would not be effective at protecting human health and the environment or reducing risk over the long term under a commercial/residential land use setting.

5.2.1.3 *Long-Term Reliability*

The No Action alternative does not satisfy the long-term reliability criteria because no action is taken to satisfy the remedial action objectives.

5.2.1.4 *Implementability*

The No Action alternative is readily implementable. However, it would be difficult to gain state and community acceptance due to the lack of action to address the affected soils.

5.2.1.5 *Implementation Risk*

Short-term risk associated with the No Action alternative is very low because no remedial actions would be taken that could potentially affect the community, site workers, or the environment. As a result, the No Action alternative would result in no short-term increase in risks to human health and the environment over current levels.

5.2.1.6 *Reasonableness of Cost*

Because the No Action alternative has no associated capital or O&M costs, it weighs favorably, strictly with respect to cost. However, this alternative has an overall lower level of cost reasonableness as it affords no protection to the environment and does nothing to satisfy the remedial action objectives.

5.2.2 *Alternative 2 - Engineered Soil Cap and Common Tasks*

Following is an evaluation of Alternative 2 with respect to the protectiveness criterion, and the five remedy selection balancing factors.

5.2.2.1 *Protectiveness*

With the engineered soil cap, the affected soils would remain on site making the magnitude of residual risk associated with these soils entirely dependent on engineering and institutional controls. Once in place, the soil cap would control direct exposure to these impacted soils provided the cap remains in place and intact. Human health risk could be controlled through ongoing cap inspections and maintenance and by restricting development activities at the site to ensure that the cap is not damaged.

Implementing the common tasks described in Section 4.4.2 would eliminate or substantially reduce the human health risk associated with the bunker C area, the oil/water separator, Ponds A and B, and the residual petroleum in the drip slab area. By implementing these actions and meeting the residential cleanup goals in these areas, the risk associated with any residual wastes would be acceptable under a commercial/residential land use scenario.

5.2.2.2 *Effectiveness*

A soil cap would effectively reduce the mobility of COCs in soil and the potential for exposure. However, the soil cap would only remain effective as long as it remained in place and has not been breached, damaged, or disturbed (i.e., during site redevelopment). The areas of the site that are capped would need to be delineated in the deed restriction language to ensure that the cap is not disturbed in the future without prior ODEQ approval.

Implementing the common elements would effectively reduce the toxicity, mobility, and volume of COCs and potential COCs associated with the Bunker C, oil/water separator, and drip slab areas. Draining and filling the ponds would eliminate future potential risks to human and ecological receptors. Properly abandoning the various wells would eliminate future potential risks to ground water.

5.2.2.3 *Long-Term Reliability*

The long-term reliability of a soil cap could be maintained through the installation of drainage and erosion controls, as well as conducting routine inspections, maintenance, and repairs. However, should the property be developed, it may be difficult to maintain soil cap integrity and provide continued protection against exposure over the long term. In addition, because contaminants would not be treated or removed from the site, the site would remain on ODEQ's list of impacted sites.

The actions listed in the common elements (Section 4.4.2) involve complete removal or closure; therefore, implementing the common elements would reliably reduce the toxicity, mobility, and volume of contaminants associated with these features over the long term.

5.2.2.4 *Implementability*

The initial application of a soil cap to the site would be implementable because it would involve the use of common construction equipment (i.e., loaders, graders, rollers) and importing certified clean soil. A constraint on the implementability of a soil cap includes difficulty in monitoring cap effectiveness or ensuring cap integrity over the long term, especially if the property changes ownership.

The common tasks could be easily implemented because they involve the use of readily available materials and standard construction equipment (i.e., excavators, backhoes, drill rigs). The extent of excavations would be determined by visual observations and, where necessary, verification sampling of the excavation sidewalls and bottom will be performed. Permits for well abandonment can be obtained through state or local agencies. Disposal facilities that accept the debris and impacted soil are available.

5.2.2.5 *Implementation Risk*

Potential short-term risks associated with the installation of a soil cap include the generation of airborne dust during grading and placement of the cap, and off-site transport of soils with runoff. The generation of airborne dust could be managed or reduced using dust suppression measures and by limiting work on windy days. Risk to site workers would be managed by implementing a health and safety plan, which would include the use of appropriate personal protective equipment (PPE). Risk to the community would be managed by restricting site access and implementing effective dust suppression methods. Runoff would be controlled through the use of erosion control measures.

Controlling site access, implementing dust suppression methods, using appropriate PPE, and proper handling of wastes would protect site workers and the community during implementation of the common tasks detailed in Section 4.4.2.

Approximately 10 to 12 months may be required to complete the tasks included in Alternative 2. Routine inspections and cap maintenance would be an ongoing requirement.

5.2.2.6 *Reasonableness of Cost*

Capital and O&M costs associated with Alternative 2 are summarized in Table 5-1 and detailed in Table 5-2. Direct and indirect capital costs associated with Alternative 2 are estimated at $1,099,400 and include equipment, materials, contractor services, and labor required for design and implementation, plus a 20 percent contingency. O&M costs include the materials, labor, and periodic oversight costs required to ensure the ongoing integrity of the soil cap and are estimated to be $10,500 per year. The net present value for O&M costs, assuming a cap life span of 30 years and an annual discount of 5 percent, is estimated at $300,000, bringing the total present value cost of Alternative 2 to $1,399,400.

Although a well-maintained soil cap would protect against exposure under the current land use scenario, the costs associated with installation and O&M would by far outweigh the benefit. Alternative 2 is the most costly alternative and provides the least amount of long-term protection, especially if the property were to undergo development.

The cost associated with implementing the common tasks is reasonable when compared to the benefits to the environment and the community.

5.2.3 *Alternative 3 - Excavation and Off-Site Disposal and Common Tasks*

Following is an evaluation of Alternative 3 with respect to the protectiveness criterion, and the five remedy selection balancing factors.

5.2.3.1 *Protectiveness*

Excavation of affected soils to residential cleanup levels and off-site disposal plus implementation of the common tasks would eliminate or substantially reduce the risk associated with human exposures under a commercial/residential setting. Therefore, the residual risk resulting after the completion of Alternative 3 would be acceptable under a commercial/residential land use scenario, because only soils containing COCs below residential cleanup levels would remain on site.

5.2.3.2 *Effectiveness*

Removal and off-site treatment and/or disposal of affected soils above residential cleanup goals (including the affected soils in the bunker C, drip slab, and oil/water separator areas) would eliminate risk under a commercial/residential land use scenario by significantly reducing their toxicity, mobility, and volume. In addition, implementing the common tasks would eliminate the risks to the neighboring community and ground water resources that are potentially associated with the ponds and wells on site.

5.2.3.3 *Long-Term Reliability*

The removal of soils above residential cleanup goals and the removal of affected soils and features (e.g., oil/water separator, Ponds A and B) associated with implementing the common tasks would ensure continued protection against exposure over the long term under a commercial/residential land use scenario.

5.2.3.4 *Implementability*

Excavation and off-site treatment/disposal of affected soils could be easily implemented because it involves the use of standard construction equipment (such as excavators, backhoes, loaders). However, the implementation could be adversely affected if disposal facilities will not accept the affected soils. This can be alleviated by sufficiently characterizing the soils in advance and obtaining landfill preapproval prior to transporting the soils. The extent of excavations would be determined by visual observations and, where necessary, sampling. Securing, placing, and compacting backfill would be easily implemented, as it requires the use of conventional equipment and readily available materials.

Implementation considerations associated with the common tasks are similar to those discussed in Section 5.2.2.4.

5.2.3.5 *Implementation Risk*

Potential short-term risks associated with excavation and off-site disposal include the generation of airborne dust during earthwork activities and runoff associated with off-site transport of site soils. The generation of airborne dust could be managed or reduced using dust suppression measures and by limiting work on windy days. Risk to site workers would be managed by implementing a health and safety plan, which would include the use of appropriate PPE. Risk to the community would be managed by restricting site access. Runoff would be controlled through the use of erosion control measures.

Additionally, controlling site access, implementing dust suppression methods, using appropriate PPE, and proper handling of wastes would protect site workers and the community during implementation of the common tasks.

The work tasks included in Alternative 3 could be completed within a relatively short time frame (3 to 4 months).

5.2.3.6 *Reasonableness of Cost*

Capital costs associated with Alternative 3 are summarized in Table 5-1 and detailed in Table 5-3. Direct and indirect capital costs associated with Alternative 3 are estimated at $878,000 and include all equipment, materials, contractor services, and labor required for design and implementation, plus a 20 percent contingency. There are no O&M costs associated with Alternative 3.

Alternative 3 is the least costly alternative and provides the best overall benefit to the environment and community over the long term. Short-term effects on workers and the neighboring community during implementation can be controlled and are outweighed by the long-term benefits resulting from the reduction in toxicity, mobility, and volume of COCs.

The cost associated with implementing the common tasks is reasonable when compared to the benefits to the environment and the community.

5.2.4 *Alternative 4 – Excavation with Asphalt Incorporation and Common Tasks*

Following is an evaluation of Alternative 4 with respect to the protectiveness criterion, and the five remedy selection balancing factors.

5.2.4.1 *Protectiveness*

Incorporating excavated soils above the residential cleanup goals into an asphalt mixture would essentially eliminate the risk associated with these soils through treatment, provided the COCs remained stable over the long term. As above, implementation of the common tasks would eliminate or reduce the risks associated with these areas. Therefore, the residual risk resulting after the completion of Alternative 4 would be acceptable under a commercial/residential land use scenario, because all soils above the residential cleanup goals would be stabilized through treatment.

5.2.4.2 *Effectiveness*

Incorporating soils above residential cleanup goals into asphalt may effectively reduce the toxicity and mobility of COCs through treatment, thereby reducing the potential for exposure. However, prior to implementation, the effectiveness of asphalt incorporation would need to be confirmed through bench or pilot testing. Finally, implementing the common tasks would eliminate the risks to the neighboring community and ground water resources that are potentially associated with the ponds and wells on site.

5.2.4.3 *Long-Term Reliability*

The reliability of asphalt incorporation at reducing toxicity and mobility over the long term has been proven at numerous similar sites. However, the long-term ability of asphalt incorporation to stabilize COCs at the Yard would need to be demonstrated through bench-scale testing and leachate testing. The removal of affected soils and features (e.g., oil/water separator and ponds) through implementing the common tasks would ensure continued protection against exposure over the long term under a commercial/residential land use scenario.

5.2.4.4 *Implementability*

Asphalt incorporation involves the use of specialized equipment, which may involve high mobilization and service costs. Additionally, the technology may be difficult to implement effectively at the Yard due to the site's mostly fine-grained soil lithology. Asphalt incorporation is most effective when coarse-grained soils (i.e., sands and gravels) are used. Finally, an end use for the asphalt must be identified before implementing this alternative.

As with Alternative 3, excavating affected soils and backfilling excavations would be easy to implement, as these tasks require the use of readily available equipment and materials.

Implementation considerations associated the common tasks are similar to those discussed in Section 5.2.3.4.

5.2.4.5 *Implementation Risk*

Potential short-term risks associated with excavation, on-site asphalt incorporation, and on-site reuse include the generation of airborne dust and vapor and off-site transport of site soils with runoff. The generation of airborne dust could be managed or reduced using dust suppression measures and by not working on windy days. Short-term exposure to site workers would be managed by implementing a health and safety plan, which would include the use of appropriate PPE. Risk to the community would be managed by restricting site access. Runoff would be controlled through the use of erosion control measures.

Additionally, controlling site access, implementing dust suppression methods, using appropriate PPE, and proper handling of wastes would protect site workers and the community during implementation of the common tasks.

The work tasks included in Alternative 4 could be completed in 3 to 4 months.

5.2.4.6 *Reasonableness of Cost*

Capital costs associated with Alternative 4 are summarized in Table 5-1 and detailed in Table 5-4. Direct and indirect capital costs associated with Alternative 4 are estimated at $975,000 and include all equipment, materials, contractor services, and labor required for design and implementation, plus a 20 percent contingency. There are no O&M costs associated with Alternative 4.

Alternative 4 is slightly more costly than Alternative 3 and, provided the COCs can be stabilized using asphalt incorporation, would provide the same level of benefit to the environment and community over the long term. Short-term affects on workers and the neighboring community during implementation can be controlled and are outweighed by the long-term benefits resulting from the reduction in toxicity and mobility of COCs.

The cost associated with implementing the common tasks is reasonable when compared to the benefits to the environment and the community.

5.2.5 *Alternative 5 – Excavation with Off-Site Disposal and On-Site Encapsulation and Common Tasks*

Following is an evaluation of Alternative 5 with respect to the protectiveness criterion, and the five remedy selection balancing factors.

5.2.5.1 *Protectiveness*

Excavation and off-site disposal of TPH-affected soils and some soils exceeding residential cleanup goals, combined with implementation of the common tasks, would substantially reduce the risk associated with human exposures under a commercial/residential setting. Excavating affected soils above residential cleanup levels and burying some of these beneath an asphalt cap would mean that untreated soils would remain on site beneath paved roadways and/or parking lots. This action would eliminate risk to potential receptors, provided that the materials underlying the pavement are not uncovered. Human health risks associated with buried soils could be controlled through ongoing inspections and maintenance, and by restricting site development activities to ensure that the cap is not damaged.

5.2.5.2 *Effectiveness*

Excavation and off-site disposal of TPH-affected soils and some soils exceeding residential goals would eliminate the risk associated with these soils by significantly reducing their toxicity, mobility, and volume. Completely enclosing some of the soils affected to a lesser degree beneath paved surfaces would be immediately effective at reducing the mobility of COCs, and the potential for human exposure provided the asphalt remains intact. Establishing utility corridors through areas of unaffected soil would ensure that future workers are not at risk of coming in contact with affected soils while conducting repairs. The areas of the site where the affected soils are enclosed would need to be delineated in the deed restriction language to ensure that the asphalt is not disturbed in the future without prior ODEQ approval. Finally, implementing the common tasks would eliminate the risks to the neighboring community and ground water resources that are potentially associated with the ponds and wells on site.

5.2.5.3 *Long-Term Reliability*

The removal of TPH soils and some soils exceeding residential cleanup goals would ensure continued long-term protection against exposure to the soils containing higher levels of impact. Long-term protection against human exposure to less affected soils enclosed beneath asphalt may be difficult to ensure. However, designing the enclosure(s) so that affected soils are not present in utility corridors would reduce the potential for encountering affected soils during future development and/or roadwork. The long-term integrity of the asphalt would be maintained through routine inspections, maintenance, and repairs. In addition, the long-term protection of ground water quality would need to be demonstrated through leachate testing of soils prior to burial. Finally, because contaminants would not be treated or removed from the site, the site will remain on ODEQ's list of impacted sites.

The removal of affected soils and features (such as oil/water separator, ponds) through implementing the common tasks would ensure continued protection against exposure over the long term under a commercial/ residential land use scenario.

5.2.5.4 *Implementability*

As discussed in the implementability evaluation for Alternative 3, excavation and off-site treatment/disposal could be easily implemented. Soil encapsulation would also be fairly easy to implement because it would involve the use of common construction equipment (i.e. loaders, graders, rollers) and readily available materials and services. Segregating and managing stockpiled soil at the site could prove to be cumbersome. A constraint on the implementability of soil encapsulation includes difficulty in monitoring its effectiveness or ensuring asphalt integrity over the long term, especially if property changes ownership.

Implementation considerations associated the common tasks are similar to those discussed in Section 5.2.3.4.

5.2.5.5 *Implementation Risk*

Potential short-term risk associated with excavation, off-site disposal, and on-site encapsulation includes the generation of airborne dust during earthwork activities and off-site transport of affected soils with runoff. The generation of airborne dust could be managed or reduced using dust suppression measures and by halting work on windy days. Risk to site workers will be managed by implementing a health and safety plan, which includes the use of appropriate PPE. Risk to the community will be managed by restricting site access. Runoff would be controlled through the use of erosion control measures.

Additionally, controlling site access, implementing dust suppression methods, using appropriate PPE, and proper handling of wastes would protect site workers and the community during implementation of the common tasks.

The work tasks included in Alternative 5 could be completed within 5 to 7 months.

5.2.5.6 *Reasonableness of Cost*

Capital and O&M costs associated with Alternative 5 are summarized in Table 5-1 and detailed in Table 5-5. Direct and indirect capital costs associated with Alternative 5 are estimated at $1,016,000 and include all equipment, materials, contractor services, and labor required for design and implementation, plus a 20 percent contingency. O&M costs include the materials, labor, and periodic oversight costs required to ensure the ongoing integrity of the asphalt cap and are estimated to be $3,500 per year. The net present value for O&M costs, assuming a cap life span of 30 years and an annual discount rate of 5 percent, is estimated at $100,000, bringing the total present value cost of Alternative 5 to $1,116,000.

Off-site disposal of TPH soils and soils with higher levels of impact, combined with on-site enclosure of less affected soils beneath a well-maintained asphalt covering, would protect against exposure under the current land use scenario. If planned carefully, it also could provide protection against exposure under a future commercial/residential development scenario. However, the benefits provided are significantly outweighed by the capital and O&M costs. Soil burial, as proposed in

Alternative 5, would cost less than the soil cap proposed in Alternative 2, primarily because it would be easier to maintain over the long term. It would also provide slightly greater benefit in that it would be easier to incorporate soil burial site(s) into future development plans.

The cost associated with implementing the common tasks is reasonable when compared to the benefits to the environment and the community.

5.3 *COMPARATIVE ANALYSIS*

The evaluation above consisted of an individual analysis of each of the five remedial action alternatives with respect to protectiveness, effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost. Below, the alternatives are compared to each other and rated based on how well each satisfies the evaluation criteria. Because all of the action alternatives involve the completion of a set of common tasks, the following comparative analysis will focus only on those actions that are different for each action alternative.

5.3.1 *Protectiveness*

The protectiveness criterion provides a means of measuring risk resulting from COCs remaining on site after the selected remedial action has been completed. Qualitatively, Alternative 3 (off-site disposal) appears to best satisfy the protectiveness criterion because it provides the most effective and long-term solution. Alternative 4 (asphalt incorporation) would be equally protective, provided the COCs could be stabilized over the long term. Alternative 5 (off-site disposal and on-site burial) would not be as effective as Alternatives 3 and 4 at providing long-term protection, but would be easier to manage and control long-term risk when compared to Alternative 2 (soil cap). The residual risk resulting from Alternative 1 (No Action) make this the least protective alternative.

5.3.2 *Effectiveness*

The effectiveness criterion measures the effectiveness at protecting human health and the environment. Alternative 3 best satisfies this criterion because it uses a proven approach for reducing toxicity, mobility, and volume of COCs. Alternative 4 could be as effective at reducing toxicity and mobility of COCs, although this has yet to be demonstrated at the site. Alternatives 2 and 5 utilize engineering controls to reduce mobility of COCs; however, Alternative 5 would provide better protection over the long term. Alternative 1 is the least effective, as it provides no measures to protect human health and the environment.

5.3.3 *Long-Term Reliability*

The long-term reliability criterion measures how well an alternative will control or manage risk over the long term. Alternative 3 offers the most permanent solution and, therefore, best satisfies this criterion. The ability for asphalt incorporation, as proposed in Alternative 4, to effectively stabilize COCs over the long term would need to be proven through leachate testing. Alternatives 2 and 5 could both control risk over the long term but would require routine inspections and maintenance. Alternative 1 provides the least amount of long-term reliability because it involves no action to control or manage risk.

5.3.4 *Implementability*

This criterion measures the degree of difficulty associated with implementation. Alternative 1 is by far the easiest to implement because no action is involved. Alternative 3 would be the easiest action alternative to implement because it involves excavation, loading, off-site transport and disposal. Alternative 4 would be as easy to implement provided an end use for the resulting asphalt is identified. Placement of a soil cap, as proposed in Alternative 2, would be relatively easy to implement, but it may be difficult to assess and verify continued effectiveness. Burying soils beneath paved surfaces (Alternative 5) would be the most difficult to manage because stockpiling and segregating soils during implementation could prove to be quite cumbersome. Additionally, it may be difficult to monitor effectiveness or ensure asphalt integrity over the long term.

5.3.5 *Implementation Risk*

The implementation risk criteria measures the degree of risk posed to site workers and the surrounding community during implementation. Alternative 1 poses no short-term risk since it involves no action. With all of the action alternatives, the majority of implementation risk is associated with the generation of dust emissions and affected runoff, which can be controlled. Alternative 2 poses the least amount of implementation risk because it involves disturbing only a minimal amount of affected soils. Alternative 3 would likely present a relatively moderate risk to site workers and the community because soil handling volumes and duration of activities are increased in comparison to Alternative 2, but are less than Alternatives 4 and 5. Alternatives 4 and 5 pose the greatest level of implementation risk because both alternatives involve handling a similar volume of soil as Alternative 3 and would take significantly longer to complete than the other alternatives.

5.3.6 *Reasonableness of Cost*

This criterion measures the total capital and O&M cost of each alternative, relative to the benefit provided to human health and the environment. Alternative 3 best satisfies this criterion because it would be the least costly, and would provide the highest degree of long-term protection. Alternative 4 would cost slightly more than Alternative 3 and, if demonstrated effective, would provide the same degree of long-term protection. Alternative 5 has the potential to provide long-term protection, but would be more costly to implement and maintain. With Alternative 2, it would be difficult to ensure long-term protection and, as a result, would be significantly more costly than the other action alternatives. Because Alternative 1 provides no benefit to human health and the environment, it would not satisfy the reasonableness of cost criterion under a commercial/residential land use development scenario.

6.0 *RECOMMENDATIONS*

This section summarizes the recommended remedial action alternative and presents a Residual Risk Assessment (RRA), which evaluates the risk to human health and the environment following completion of the remedial action.

6.1 *RECOMMENDED REMEDIAL ACTION ALTERNATIVE*

Alternative 3 is the recommended alternative because it best satisfies the protectiveness criteria, remedy selection-balancing factors and is cost effective. Alternative 3 includes excavation and off-site disposal of soils exceeding residential cleanup goals, and implementation of the common tasks described in Section 4.4.2. By implementing the actions included in Alternative 3, the following would be achieved:

- Human health and the environment would be protected over the long term under a commercial/residential land use scenario;
- The residual risk associated with COCs remaining after remediation would be acceptable as described in Section 6.2, below;
- Workers and the public would be protected during implementation through the use of dust and erosion controls; and
- Excavation and off-site disposal would be the easiest, quickest, and most cost-effective means of handling soils that exceed residential cleanup goals.

6.2 *RESIDUAL RISK ASSESSMENT*

In accordance with ODEQ requirements, this FS includes an RRA to evaluate the potential risks associated with COCs remaining in soils following completion of the recommended remedial activities under Alternative 3 discussed in Section 5.2.3. This section describes the methodology used to develop the RRA and presents the results of this analysis. Consistent with risk assessment guidance developed by ODEQ and USEPA, this section is organized as follows:

- Data evaluation;

- Exposure assessment;
- Toxicity assessment; and
- Risk characterization.

6.2.1 *Data Evaluation*

The Final RI Report for the Yard (ERM, 1999) presented risk-based cleanup levels for COCs in soil. These were listed in the Final RI Report in Table 56 and are summarized in this report in Table 2-1. The values presented on Table 2-1 for a residential scenario are the applicable cleanup goals for the Yard. This RRA considers all constituents for which risk-based cleanup levels were developed.

6.2.2 *Exposure Assessment*

Soil cleanup levels for all portions of Ashland Yard will be based on a commercial/residential land use scenario as discussed in Section 2.5. Selection of this land use scenario is conservative, in light of planned future uses of Ashland Yard.

Exposure assumptions (i.e., exposure pathways and intake parameters) used in the residual risk analysis were consistent with the assumptions used to develop the industrial and residential land use scenarios in the Health and Ecological Risk Assessment included in Section 5 of the Final RI Report. (Section 5 of the Final RI Report provides a complete discussion of the exposure pathways and intake parameters associated with residential land use.)

Exposure point concentrations used in the RRA were based on the maximum residual constituent concentrations that may be present in soil following remediation to residential cleanup levels. Soil data used to define these exposure point concentrations were based on the complete tabulation of soil data presented in the Final RI Report and in Tables 2-2, 2-3, and 2-4 of this report. For the exposure assessment, these concentrations are assumed to be in surface soils or soils otherwise directly available to human contact.

6.2.3 *Toxicity Assessment*

Toxicity data used in the RRA were consistent with data used in the Health and Ecological Risk Assessment and in the calculation of risk-based cleanup levels for Ashland Yard (ERM, 1999).

6.2.4 *Risk Characterization*

The calculation of residual risks presented in this RRA followed the approach used in the Health and Ecological Risk Assessment to derive risk-based cleanup levels. The specific steps associated with these calculations are as follows:

- First, the risk-based residential cleanup goals were compiled (Table 6-1), based on the residential levels presented in Table 2-1. Maximum residual soil concentrations reported in Table 2-1 were derived from the highest concentrations of each contaminant detected in soils outside of the planned remediation areas. The maximum detected concentrations were used to provide a conservative estimate of residual risk.
- As noted above, the RRA considered all constituents for which risk-based levels were developed in the RI.
- Next, the toxicological basis (i.e., carcinogenic effects, noncarcinogenic effects, or blood lead level) for each risk-based cleanup level was determined (Table 6-1), based on information presented in the Final RI Report.
- Then, the maximum residual soil concentrations were identified and tabulated (Table 6-1). For each constituent, the maximum residual concentration is equal to the maximum detected concentration that is less than the applicable cleanup level. The identification of residual concentrations was based on a compilation of all soil samples that did not contain an exceedence of any applicable cleanup level. Soil samples that showed an exceedence of any cleanup level were excluded from this compilation and were not considered in the identification of maximum residual constituent concentrations.
- The residual carcinogenic risk was then estimated for each carcinogenic constituent according to the following formula:[1]

  Risk = 0.000001 x Residual Concentration/Risk-Based Cleanup Level
- The residual hazard index was estimated for each noncarcinogenic constituent, according to the following formula:

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[1] This formula incorporates a target risk level of one in one million (0.000001), consistent with the target risk level used to derive the risk-based cleanup levels for carcinogenic constituents.

Hazard Index = Residual Concentration/Risk-Based Cleanup Level

- The total excess lifetime carcinogenic risk was then calculated as the sum of the constituent risks; similarly, the total hazard index was calculated as the sum of the constituent hazard indices (Table 6-1).

As shown in Table 6-1, the total excess lifetime carcinogenic risk is 3×10^{-6}.[2] This represents an upper bound estimate of the excess lifetime carcinogenic risk associated with exposure to residual soil constituents under a residential land use scenario. The total risk is well below the acceptable level of cumulative carcinogenic risk defined by ODEQ (1×10^{-5}). The risk associated with each individual constituent is also acceptable under ODEQ guidelines (i.e., the excess lifetime carcinogenic risk associated with each constituent is less than 1×10^{-6}).

Similarly, the total noncarcinogenic hazard index is less than one, indicating that no adverse noncarcinogenic health effects are anticipated to be associated with exposure to residual soil constituents under a commercial/residential land use scenario.

Maximum site-wide residual concentrations were used in the RRA to simplify the calculation and presentation of residual risk. It must be emphasized that the use of maximum concentrations in this analysis represents a very conservative approach and that any residual risk is likely to be much less than estimated in this evaluation.

As noted on Table 6-1, arsenic and lead were not considered in the calculation of cumulative risks. The reasons for their exclusion are discussed below:

- Arsenic occurs naturally in soils, and the cleanup level for arsenic was based on site-specific information regarding typical arsenic concentrations in soils in the vicinity of the Yard. Because the cleanup level for arsenic is not risk-based, arsenic was not considered in the calculation of cumulative risks.
- The risk-based cleanup level for lead is based on estimated blood lead concentrations, rather than on carcinogenic risk or noncarcinogenic

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[2] An estimated risk of 1×10^{-6} represents a unitless probability of one in one million that a carcinogenic response will occur during an individual's lifetime as a result of the defined conditions of exposure.

hazard. For this reason, lead was not considered in the cumulative risk calculations. However, residual lead concentrations will be less than the defined cleanup levels, indicating that residual concentrations of lead are not expected to result in unacceptable blood lead levels.

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7.0 *REFERENCES*

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Figures

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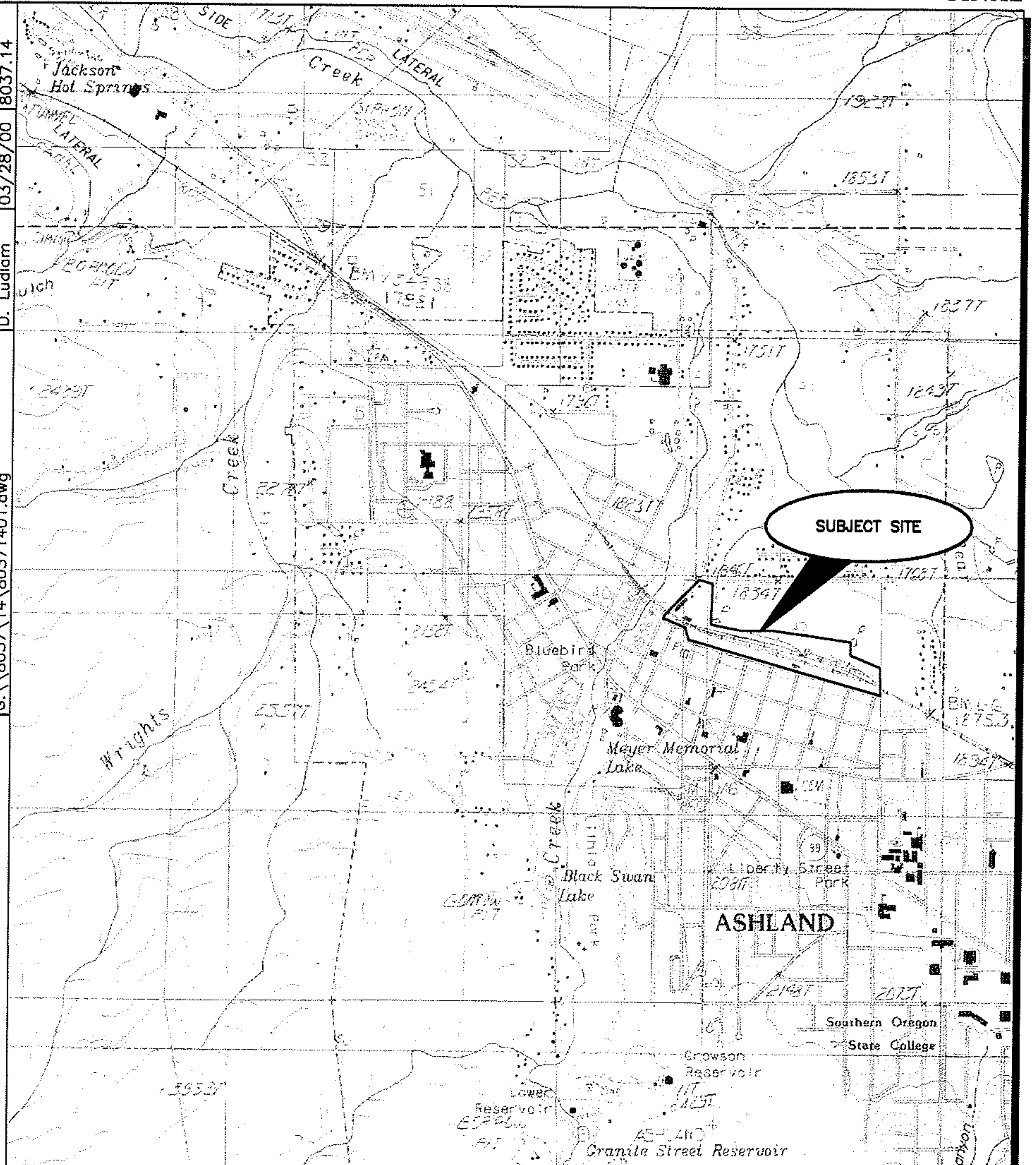

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Figure 1-1
Site Location Map
Union Pacific Railroad Company
Ashland Yard
Ashland, Oregon

ERM 03/00

References:
U.S.G.S. 7.5 Minute Series (Topographic Ashland Quadrangle, Oregon)
Dated: 1978; Photorevised 1983

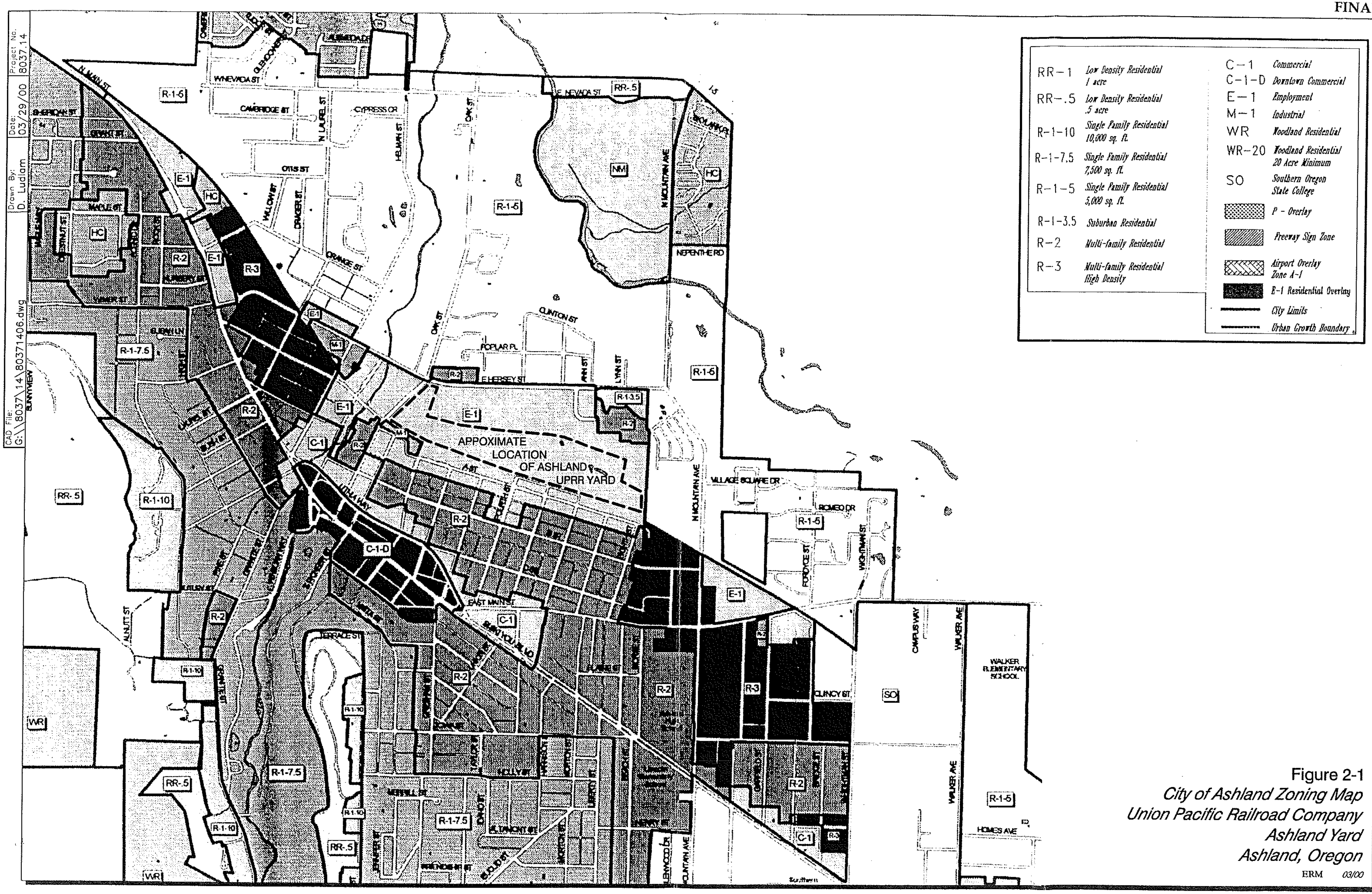

Figure 2-1
City of Ashland Zoning Map
Union Pacific Railroad Company
Ashland Yard
Ashland, Oregon

ERM 03/00

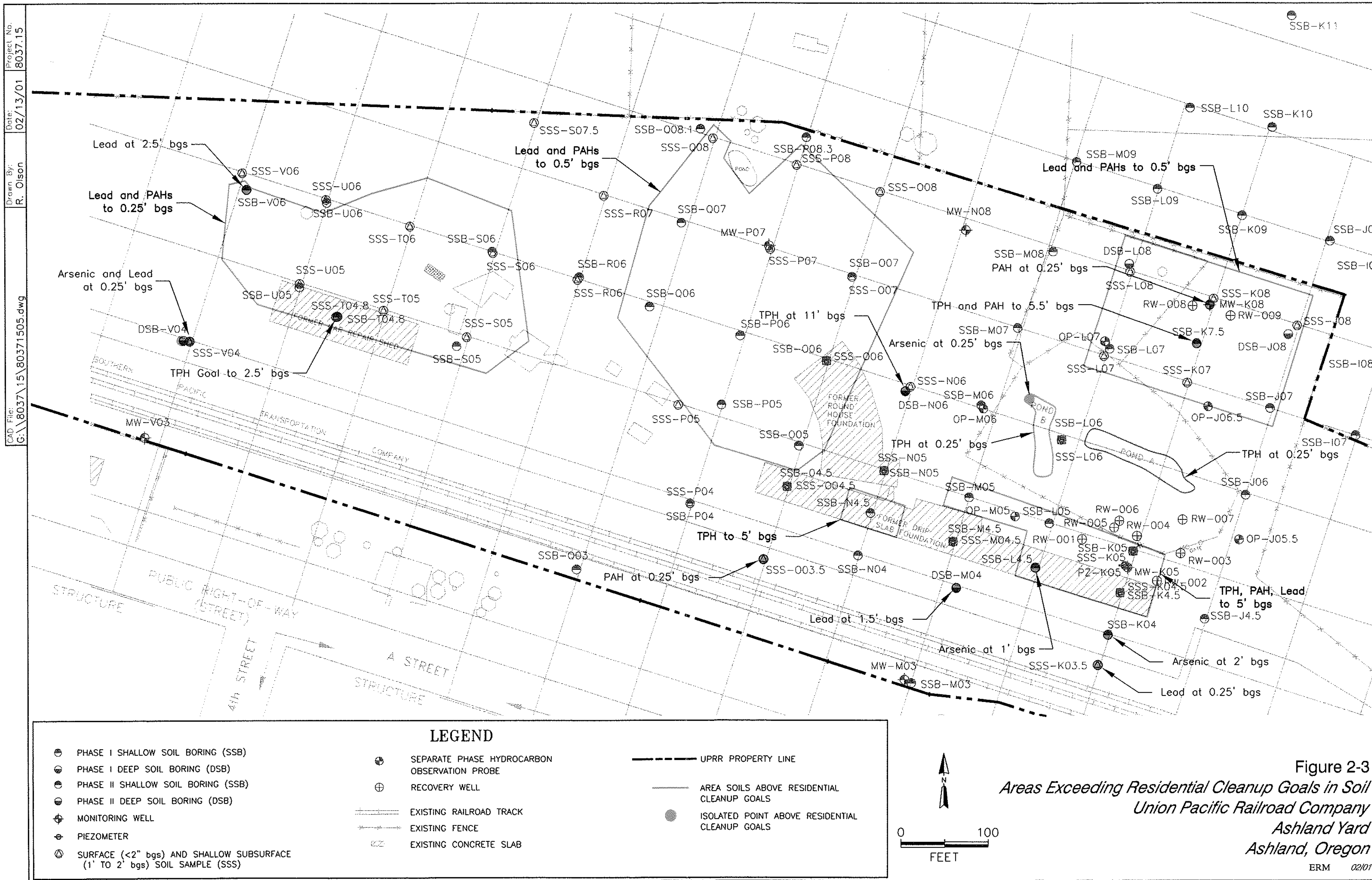

Figure 2-3
Areas Exceeding Residential Cleanup Goals in Soil
Union Pacific Railroad Company
Ashland Yard
Ashland, Oregon

ERM 02/01

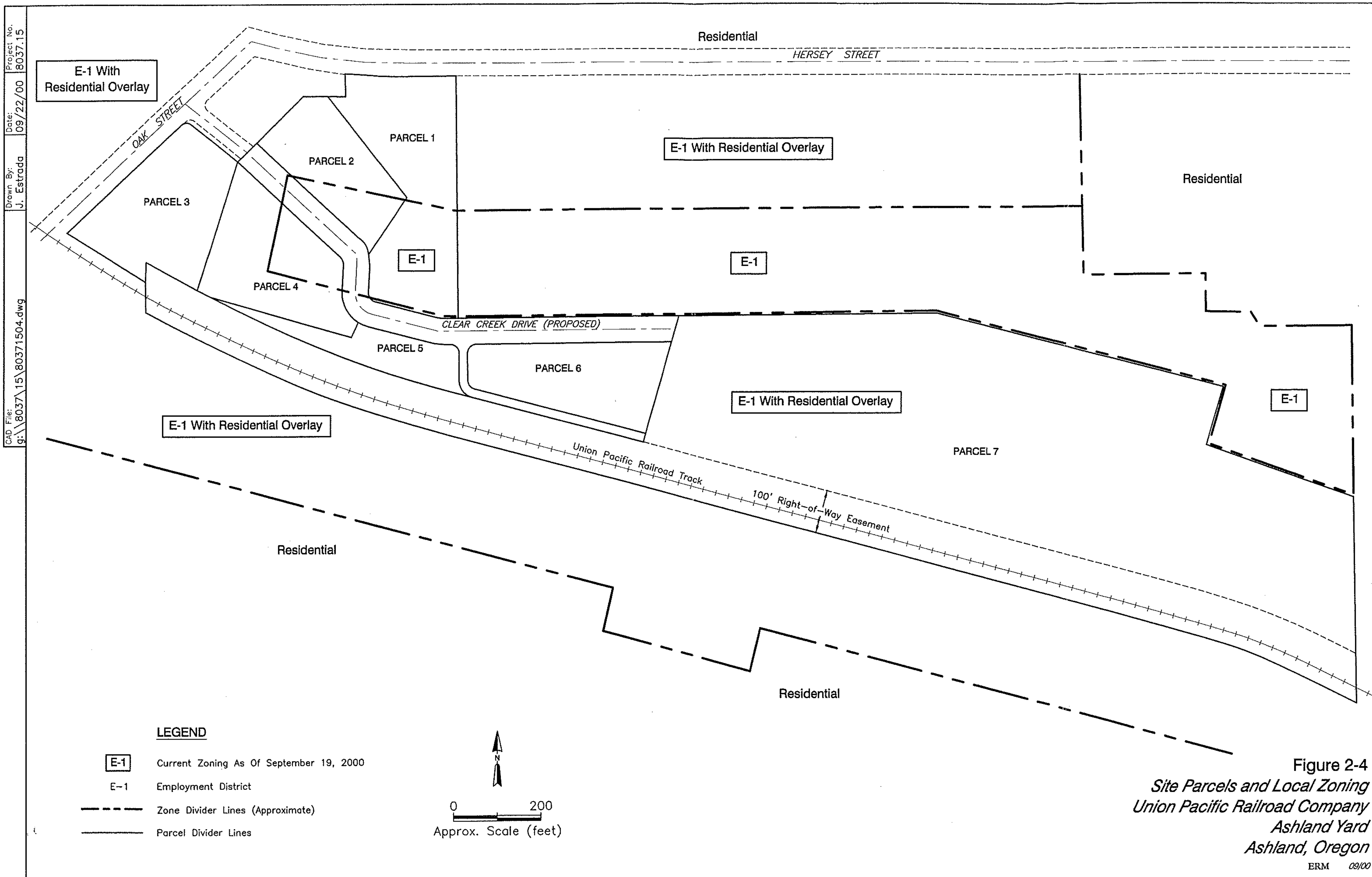

Figure 2-4
Site Parcels and Local Zoning
Union Pacific Railroad Company
Ashland Yard
Ashland, Oregon

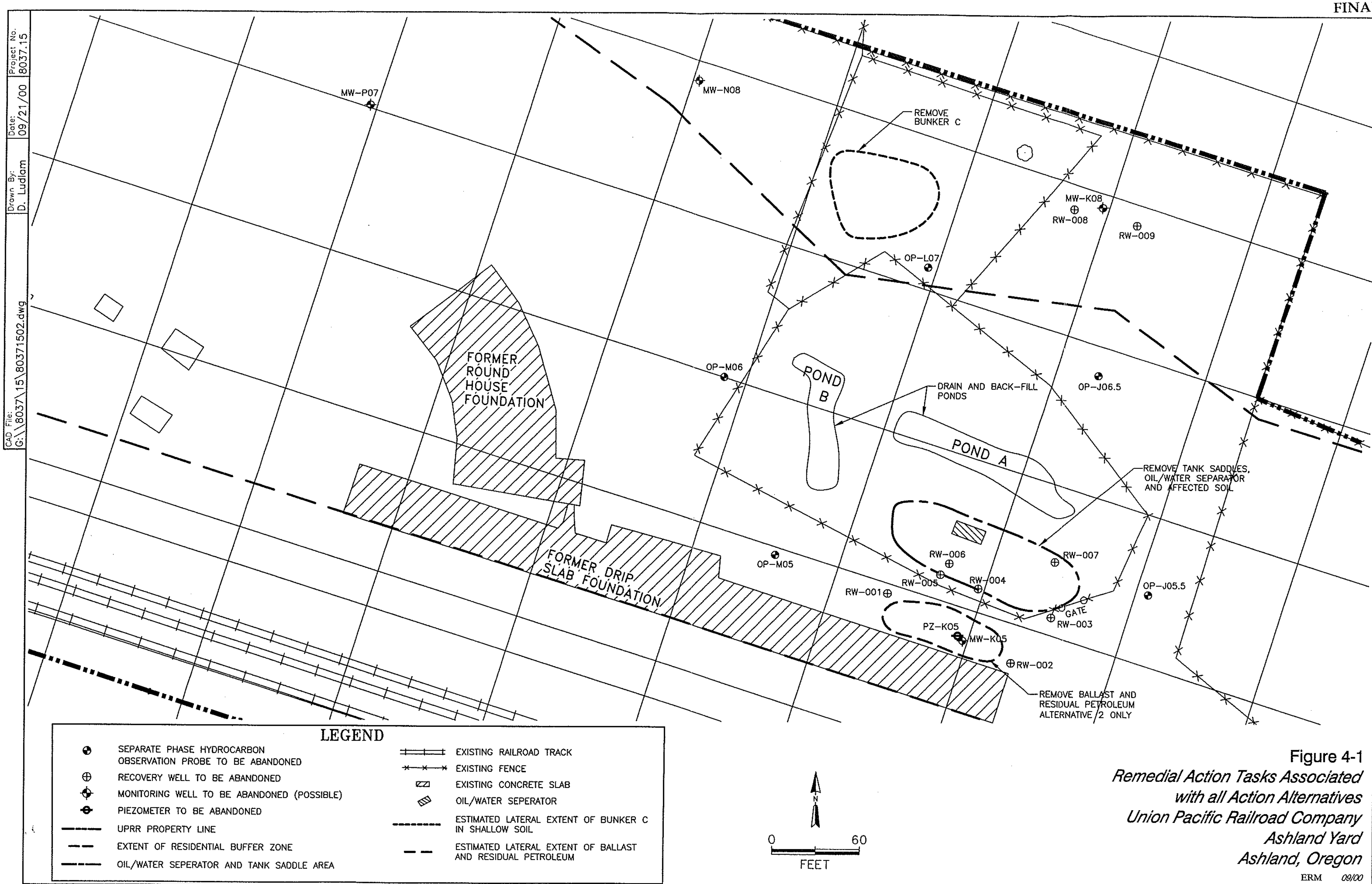

Figure 4-1
Remedial Action Tasks Associated with all Action Alternatives
Union Pacific Railroad Company
Ashland Yard
Ashland, Oregon

ERM 09/00

Tables

Table 2-1 Risk-Based Cleanup Goals for Constituents of Concern in Soil
Residential Land Use Scenarios
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Chemicals	Residential Land Use Scenario Risk-Based Cleanup Goals (mg/kg)	Carcinogen?
Volatile Organic Chemicals		
Benzene	0.27	Yes
Ethylbenzene	392	No
Toluene	NA	NA
Xylenes	146,500	No
Semivolatile Organic Chemicals		
Acenaphthene	3,116	No
Acenaphthylene	NA	NA
Anthracene	15,580	No
Benzo(a)anthracene	0.64	Yes
Benzo(a)pyrene	0.06	Yes
Benzo(b)fluoranthene	0.64	Yes
Benzo(g,h,i)perylene	NA	NA
Benzo(k)fluoranthene	6.37	Yes
Chrysene	63.7	Yes
Dibenz(a,h)anthracene	0.06	Yes
Fluoranthene	2,077	No
Fluorene	2,077	No
Indeno(1,2,3-cd)pyrene	0.64	Yes
Naphthalene	2,077	No
Phenanthrene	NA	NA
Pyrene	1,558	No
Petroleum Hydrocarbons		
Total Petroleum Hydrocarbons	1,558	No
Inorganics		
*Arsenic	30	Yes
Barium	2,161	No
Cadmium	34.5	Yes
Chromium	15,140	No
**Lead	200	No
Mercury	16.2	No
Selenium	366	No
Silver	284	No

Cleanup goals for residential land use scenario developed based on residential exposure assumptions.
Goals for carcinogenic chemicals of concern (COCs) based on 1 x 10^{-6} lifetime cancer risk.
Goals for non-carcinogenic COCs based on a hazard quotient of 1.0.
* Soil concentration based on background, not risk.
** Soil concentration based on Oregon Department of Environmental Quality soil action levels.
mg/kg Milligrams per kilogram
NA Not calculated due to lack of slope factor or reference dose.

Table 2-2 *Total Petroleum Hydrocarbon Concentrations in Soil*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	TPH (Speciation Results)[a]	Diesel	Gasoline
DSB-J08	0.5	03/29/94	NA	542	NA
DSB-J08	5	03/29/94	NA	81	NA
DSB-J08	10	03/29/94	NA	<20	NA
DSB-M04	0.5	03/29/94	219	220	NA
DSB-M04	3	03/29/94	<20	NA	NA
DSB-M04	10.5	03/29/94	<20	NA	NA
DSB-N06	0.5	03/28/94	150	234	NA
DSB-N06	3	03/29/94	<20	NA	NA
DSB-N06	5	03/29/94	NA	<20	NA
DSB-N06	10	03/29/94	NA	1,060	NA
DSB-N06	11	03/29/94	1,700	1,700	NA
DSB-V04	4.5	05/09/96	NA	<20	NA
DSB-V04	8	05/09/96	297	47 NJT	NA
DSB-V04	14.5	05/09/96	NA	<20	NA
DSB-V04	18.5	05/09/96	NA	<20	NA
DSB-V04	21	05/09/96	NA	<20	NA
MW-K05	3.5	05/11/96	NA	6,880 J	NA
MW-K05	7.5	05/11/96	NA	1,800 NJO	NA
MW-K05	10	05/11/96	NA	<20	NA
MW-Q03	2.5	05/12/96	NA	<20	NA
MW-Q03	6	05/12/96	NA	<20	NA
MW-Q03	10	05/12/96	NA	<20	NA
MW-V03	3	05/20/96	NA	<20	<10
MW-V03	8	05/20/96	NA	<20	<10
P2-1	9	05/20/96	NA	<20	NA
P4-1	3	05/20/96	NA	3,270 NJO	NA
P5-1	3	05/20/96	NA	<20	NA
P6-1	3	05/20/96	NA	447 NJO	NA
P7-1	3	05/20/96	NA	20 N	NA
P9-1	3	05/20/96	NA	51 NJO	NA
P10-1	3	05/20/96	NA	<20	NA
P11-1	3	05/20/96	NA	<20	NA
P12-1	3	05/20/96	NA	488 NJO	NA
P13-1	3	05/20/96	NA	<20	NA
P14-1	3	05/20/96	NA	<20	NA
Pond-A-S-001		04/07/94	3,300	478	NA
Pond-A-S-002		04/07/94	640	945	NA
Pond-B-S-001		04/07/94	180	230	NA
Pond-B-S-002		04/07/94	2,200	300	NA
SSB-I07	2	05/29/96	NA	<20	NA
SSB-I07	6	05/29/96	NA	<20	NA
SSB-I08	2	05/29/96	NA	<20	NA
SSB-I08	7	05/29/96	NA	<20	NA
SSB-J04.5	2	03/24/94	NA	<20	NA
SSB-J04.5	5	03/24/94	NA	<20	NA
SSB-J04.5	10	03/24/94	NA	<20	NA
SSB-J06	0.5	04/05/94	NA	<20	NA
SSB-J06	5	04/05/94	NA	<20	NA
SSB-J06	10	04/05/94	NA	<20	NA

Table 2-2 *Total Petroleum Hydrocarbon Concentrations in Soil*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	TPH (Speciation Results)[a]	Diesel	Gasoline
SSB-J07	0.5	03/28/94	NA	406	NA
SSB-J07	5	03/28/94	NA	<20	NA
SSB-J07	10	03/28/94	NA	<20	NA
SSB-J09	2	05/29/96	NA	<20	NA
SSB-J09	7	05/29/96	NA	<20	NA
SSB-K04	2	03/22/94	NA	148	NA
SSB-K04	5	03/22/94	NA	1,220	NA
SSB-K04	10	03/22/94	NA	<20	NA
SSB-K04.5	1	03/24/94	NA	1,850	NA
SSB-K04.5	5	03/24/94	NA	15,000	NA
SSB-K04.5	10	03/24/94	NA	<20	NA
SSB-K05	1	03/22/94	NA	10,000	NA
SSB-K05	5.5	03/22/94	NA	5,400	NA
SSB-K05	15	03/22/94	NA	453	NA
SSB-K07.5	0.5	03/28/94	NA	<20	NA
SSB-K07.5	1	03/28/94	2,900	2,900	NA
SSB-K07.5	2	03/28/94	NA	2,350	NA
SSB-K07.5	5	03/28/94	NA	16,000	NA
SSB-K07.5	5.5	03/28/94	32,000	32,000	NA
SSB-K07.5	10	03/28/94	NA	<20	NA
SSB-K07.5	10.5	03/28/94	<20	NA	NA
SSB-K07.5	15	03/28/94	NA	<20	NA
SSB-K09	2	05/29/96	NA	<20	NA
SSB-K09	7	05/29/96	NA	<20	NA
SSB-L04.5	1	03/23/94	NA	7,700	NA
SSB-L04.5	5	03/23/94	NA	4,480	NA
SSB-L04.5	10	03/23/94	NA	<20	NA
SSB-L05	2	03/28/94	NA	1,620 J	NA
SSB-L05	4	03/24/94	NA	1,000	NA
SSB-L05	5.5	03/24/94	NA	146	NA
SSB-L05	6	03/24/94	NA	<20	NA
SSB-L05	10	03/24/94	NA	<20	NA
SSB-L06	0.5	03/28/94	NA	1,480	NA
SSB-L06	5	03/28/94	NA	279	NA
SSB-L06	10	03/28/94	NA	<20	NA
SSB-L07	0.5	03/28/94	NA	284	NA
SSB-L07	5	03/28/94	NA	275	NA
SSB-L07	10	03/28/94	NA	<20	NA
SSB-L07	15	03/28/94	NA	<20	NA
SSB-L09	2	05/28/96	NA	130 NJO	NA
SSB-L09	6.5	05/28/96	NA	<20	NA
SSB-L10	2	05/29/96	NA	<20	NA
SSB-L10	7	05/29/96	NA	<20	NA
SSB-M03	2.5	05/11/96	NA	<20	NA
SSB-M03	7.5	05/11/96	NA	<20	NA
SSB-M04	0.5	03/22/94	NA	79	NA
SSB-M04	2	03/22/94	NA	<20	NA
SSB-M04	5	03/22/94	NA	<20	NA
SSB-M04	10	03/22/94	NA	<20	NA

Table 2-2 *Total Petroleum Hydrocarbon Concentrations in Soil*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	TPH (Speciation Results)[a]	Diesel	Gasoline
SSB-M04.5	1	03/23/94	NA	551	NA
SSB-M04.5	4.5	03/23/94	NA	<20	NA
SSB-M04.5	10	03/23/94	NA	<20	NA
SSB-M05	1	03/24/94	NA	136	NA
SSB-M05	2	03/24/94	NA	41	NA
SSB-M05	5	03/24/94	NA	1,670	NA
SSB-M05	8	03/17/94	NA	254	NA
SSB-M05	10	03/17/94	NA	<20	NA
SSB-M06	0.5	03/28/94	NA	<20	NA
SSB-M06	5	03/28/94	NA	<20	NA
SSB-M06	10	03/28/94	NA	<20	NA
SSB-M08	0.5	03/28/94	NA	786	NA
SSB-M08	5	03/28/94	NA	<20	NA
SSB-M08	10	03/28/94	NA	<20	NA
SSB-M08	11.8	03/28/94	NA	<20	NA
SSB-M09	2	05/29/96	NA	<20	NA
SSB-M09	7	05/29/96	NA	<20	NA
SSB-N04	2	03/30/94	NA	<20	NA
SSB-N04	6	03/30/94	NA	182	NA
SSB-N04.5	1	03/23/94	NA	<20	NA
SSB-N04.5	5	03/23/94	NA	3,760	NA
SSB-N04.5	10	03/23/94	NA	821	NA
SSB-N05	2	03/24/94	NA	361	NA
SSB-N05	5	03/24/94	NA	956	NA
SSB-N05	10	03/24/94	NA	<20	NA
SSB-O4.5	0.5	03/22/94	NA	<20	NA
SSB-O4.5	5	03/28/94	NA	<20	NA
SSB-O05	0.5	03/24/94	NA	554	NA
SSB-O05	4	03/24/94	NA	<20	NA
SSB-O05	6	03/24/94	NA	<20	NA
SSB-O05	10	03/24/94	NA	<20	NA
SSB-O06	0.5	03/30/94	NA	193	NA
SSB-O06	5	03/30/94	NA	208	NA
SSB-O06	12	03/30/94	NA	<20	NA
SSB-O07	0.5	03/25/94	NA	691	NA
SSB-O07	5	03/25/94	NA	<20	NA
SSB-O07	10	03/25/94	NA	<20	NA
SSB-O07	12	03/25/94	NA	<20	NA
SSB-P04	2	03/22/94	NA	<20	NA
SSB-P04	5	03/22/94	NA	<20	NA
SSB-P04	10	03/22/94	NA	<20	NA
SSB-P04	15	03/22/94	NA	<20	NA
SSB-P05	0.5	03/25/94	NA	662	NA
SSB-P05	5	03/25/94	NA	<20	NA
SSB-P05	9	03/25/94	NA	<20	NA
SSB-P06	0.5	03/30/94	NA	40	NA
SSB-P06	5	03/30/94	NA	<20	NA
SSB-P06	6.5	03/29/94	<20	NA	NA
SSB-P06	6.5	03/29/94	NA	<20	NA

Table 2-2 *Total Petroleum Hydrocarbon Concentrations in Soil*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	TPH (Speciation Results)[a]	Diesel	Gasoline
SSB-P06	9.5	03/30/94	<20	NA	NA
SSB-P06	9.5	03/30/94	NA	<20	NA
SSB-P06	10	03/30/94	NA	<20	NA
SSB-P06	14	03/30/94	<20	NA	NA
SSB-P06	14	03/30/94	NA	<20	NA
SSB-P08.3	2.5	05/11/96	NA	<20	NA
SSB-P08.3	5	05/11/96	NA	<20	NA
SSB-Q06	0.5	03/25/94	NA	1,060	NA
SSB-Q06	2	03/25/94	NA	<20	NA
SSB-Q06	5	03/25/94	NA	<20	NA
SSB-Q06	10	03/25/94	NA	<20	NA
SSB-Q07	0.5	03/25/94	NA	<20	NA
SSB-Q07	1	03/25/94	NA	<20	NA
SSB-Q07	5	03/25/94	NA	1,140	NA
SSB-Q07	10	03/25/94	NA	<20	NA
SSB-Q08.1	2.5	05/11/96	NA	<20	NA
SSB-Q08.1	4.5	05/11/96	NA	<20	NA
SSB-Q08.1	9	05/11/96	NA	<20	NA
SSB-R06	2.5	05/10/96	NA	<20	NA
SSB-R06	5	05/10/96	NA	<20	NA
SSB-R06	7.5	05/10/96	NA	<20	NA
SSB-S05	4.5	05/13/96	NA	<20	NA
SSB-S05	8	05/13/96	NA	<20	NA
SSB-S06	2.5	05/10/96	NA	<20	NA
SSB-S06	5	05/10/96	NA	<20	NA
SSB-S06	9.5	05/10/96	NA	<20	NA
SSB-S06	12.5	05/10/96	NA	<20	NA
SSB-T04.8	2.5	05/10/96	1,686	1,350 J	NA
SSB-T04.8	7.5	05/10/96	NA	<20	NA
SSB-T04.8	12	05/10/96	NA	<20	NA
SSB-U05	3.5	05/13/96	NA	<20	NA
SSB-U05	5	05/13/96	NA	<20	NA
SSB-U05	8	05/13/96	NA	<20	NA
SSB-U05	11	05/13/96	NA	<20	NA
SSB-U06	5	05/10/96	NA	<20	NA
SSB-U06	7	05/10/96	NA	<20	NA
SSB-V06	2.5	05/10/96	NA	<20	NA
SSB-V06	5	05/10/96	NA	<20	NA
SSS-R06	0.25	05/12/96	NA	<20	NA
SSS-R07	0.25	05/12/96	NA	<20	NA
SSS-S05	0.25	05/12/96	NA	<20	NA
SSS-S06	0.25	05/12/96	NA	<20	NA
SSS-S07.5	0.25	05/12/96	NA	<20	NA
SSS-T04.8	0.25	05/12/96	NA	NA	2,210 J
SSS-T05	0.25	05/12/96	NA	<20	NA
SSS-T06	0.25	05/12/96	NA	<20	NA
SSS-U05	0.25	05/12/96	NA	<20	NA
SSS-U06	0.25	05/12/96	NA	<20	NA
SSS-V04	0.25	05/12/96	NA	<20	NA

Table 2-2 *Total Petroleum Hydrocarbon Concentrations in Soil*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	TPH (Speciation Results)[a]	Diesel	Gasoline
SSS-V06	0.25	05/12/96	NA	<20	NA
Industrial Worker Screening Level			17,090	17,090	17,090
Resident Screening Level			1,558	1,558	1,558

Notes and Key:

a = Speciation results indicate all TPH from carbon chain ranges C_6 to $>C_{28}$.

Units reported in milligrams per kilogram (mg/kg)

[light shading] Detection reported at or above the Resident Screening Level.

[dark shading] Detection reported at or above the Industrial Worker Screening Level.

TPH = Total petroleum hydrocarbons

J = Analyte was positively identified, value is an approximate concentration.

N = Tentatively identified.

NJO = The product has been tentatively identified as oil with peaks extending into the diesel range.

NJT = The product has been tentatively identified as weathered gasoline with peaks extending into the diesel range.

Table 2-3 *Polynuclear Aromatic Hydrocarbon Concentrations in Soil*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	ACNE	ACNL	ANT	B(a)A	B(a)P	B(b)F	B(ghi)P	B(k)F	CHRY	D(ah)A	FA	FLOR	I(1,2,3-cd)P	NAP	PA	PYR
DSB-M04	0.5	03/29/94	<0.005	<0.005	<0.005	<0.005	0.006	0.008	0.006	<0.005	0.011	<0.005	0.009	<0.005	0.009	0.01	0.01	0.022
DSB-M04	3	03/29/94	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
DSB-M04	10.5	03/29/94	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
DSB-N06	0.5	03/28/94	<0.005	<0.005	<0.005	0.006	0.006	0.009	0.016	<0.005	0.007	<0.005	0.005	<0.005	0.01	0.005	0.007	0.015
DSB-N06	3	03/29/94	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
DSB-N06	11	03/29/94	<0.005	<0.005	0.03	0.012	0.012	0.008	0.006	0.013	0.05	<0.005	0.013	0.029	<0.005	<0.005	<0.005	0.055
DSB-V04	4.5	05/09/96	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	0.0056	<0.0024	<0.0024
DSB-V04	8	05/09/96	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	0.057	0.0012	<0.0022
DSB-V04	14.5	05/09/96	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	0.00093	<0.0022	<0.0022
DSB-V04	18.5	05/09/96	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	0.0011	<0.0026	<0.0026	<0.0026	<0.0026	0.00092
DSB-V04	21	05/09/96	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Pond-A-S-001		04/07/94	0.2	0.028	0.059	<0.005	0.008	0.012	0.008	<0.005	0.019	<0.005	0.049	0.33	<0.005	0.019	0.51	0.092
Pond-A-S-002		04/07/94	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	0.016	<0.005	0.008	<0.005	0.005	<0.005	0.0009	<0.005	0.007	0.014
Pond-B-S-001		04/07/94	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	0.006	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.008
Pond-B-S-002		04/07/94	0.36	0.021	0.34	<0.005	<0.005	<0.005	<0.005	<0.005	0.012	<0.005	0.029	0.12	<0.005	<0.005	0.49	0.083
SSB-K07.5	1	03/28/94	<0.020	<0.020	<0.020	0.06	0.08	0.11	0.26	0.03	0.11	0.05	0.03	<0.020	0.14	0.02	0.07	0.19
SSB-K07.5	5.5	03/28/94	1.8	0.7	1.5	3.1	1.1	0.5	1.1	0.6	3.6	0.3	1.4	4.5	0.4	0.2	18	8.7
SSB-K07.5	10.5	03/28/94	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
SSB-P06	6.5	03/29/94	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
SSB-P06	9.5	03/30/94	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
SSB-P06	14	03/30/94	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
SSB-R06	2.5	05/10/96	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	NA	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023
SSB-R06	5	05/10/96	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	NA	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022
SSB-R06	7.5	05/10/96	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	<0.0022	NA	<0.0022	<0.0022	<0.0022	0.0012	<0.0022	<0.0022	<0.0022	<0.0022	0.0012
SSB-R06	12	05/10/96	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	NA	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023
SSB-T04.8	2.5	05/10/96	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	NA	<0.0025	<0.0025	0.0012	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
SSB-T04.8	7.5	05/10/96	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	NA	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
SSB-T04.8	12	05/10/96	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	NA	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023	<0.0023
SSS-J08	0.25	05/14/96	<0.210	<0.210	<0.210	0.092	0.085	0.14	0.12	<0.210	0.1	<0.210	0.13	<0.210	0.094	0.067	0.12	0.17
SSS-K04.5	0.25	05/13/96	<0.220	<0.220	<0.220	0.24	0.087	0.16	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	0.1	<0.220	0.65
SSS-K05	0.25	05/14/96	<0.220	<0.220	<0.220	<0.220	0.11	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	0.11	<0.220	<0.220
SSS-K07	0.25	05/14/96	<0.230	<0.230	<0.230	<0.230	0.14	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	0.08
SSS-K08	0.25	05/14/96	<0.220	<0.220	<0.220	0.13	0.24	<0.220	<0.220	<0.220	0.15	<0.220	<0.220	<0.220	<0.220	0.17	<0.220	0.086
SSS-L06	0.25	05/14/96	<0.240	<0.240	<0.240	<0.240	<0.240	<0.240	<0.240	<0.240	<0.240	<0.240	<0.240	<0.240	<0.240	<0.240	<0.240	<0.240
SSS-L07	0.25	05/14/96	<0.230	<0.230	<0.230	0.21	0.14	0.21	0.27	0.071	0.23	0.12	0.12	<0.230	0.24	0.15	0.12	0.15
SSS-L08	0.25	05/14/96	<0.240	<0.240	<0.240	0.17	0.095	0.09	0.2	<0.240	0.16	<0.240	<0.240	<0.240	<0.240	<0.240	<0.240	0.13
SSS-M04.5	0.25	05/13/96	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	0.12	<0.200	0.077
SSS-N05	0.25	05/14/96	<0.022	<0.022	<0.200	<0.200	0.011	0.011	<0.022	<0.022	0.013	<0.022	<0.022	<0.022	<0.022	0.0073	<0.022	0.0067
SSS-O03.5	0.25	05/13/96	0.0066	0.0049	0.017	0.054	0.063	0.083	<0.002	0.02	0.07	<0.002	0.11	0.0028	0.035	0.17	0.065	0.089
SSS-O04.5	0.25	05/13/96	<0.022	<0.022	<0.022	<0.022	<0.022	<0.022	<0.022	<0.022	0.0091	<0.022	<0.022	<0.022	<0.022	0.0086	<0.022	0.0086
SSS-O06	0.25	05/14/96	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220	<0.220
SSS-O08	0.25	05/13/96	<0.021	<0.021	<0.021	0.03	<0.021	<0.021	<0.021	<0.021	<0.021	<0.021	0.019	<0.021	<0.021	<0.021	0.012	0.019
SSS-P07	0.25	05/13/96	<2.2	<2.2	<2.2	2.1	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2
SSS-P08	0.25	05/13/96	<0.230	<0.230	<0.230	0.093	0.11	0.079	0.12	<0.230	0.095	<0.230	<0.230	<0.230	0.079	0.079	<0.230	<0.230
SSS-Q08	0.25	05/14/96	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230	<0.230
SSS-R06	0.25	05/12/96	<0.021	<0.021	<0.021	<0.021	0.019	<0.021	<0.021	<0.021	<0.021	<0.021	<21	<0.021	<0.021	0.015	<0.021	<0.021
SSS-R07	0.25	05/12/96	<0.021	<0.021	0.014	0.021	<0.021	<0.021	<0.021	<0.021	<0.021	<0.021	0.032	<0.021	<0.021	0.022	0.054	0.038
SSS-S05	0.25	05/12/96	0.16	<0.020	0.015	0.024	0.036	0.044	<0.020	0.026	0.044	<0.020	0.097	<0.020	<0.020	0.036	0.052	0.17

Table 2-3 *Polynuclear Aromatic Hydrocarbon Concentrations in Soil*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	ACNE	ACNL	ANT	B(a)A	B(a)P	B(b)F	B(ghi)P	B(k)F	CHRY	D(ah)A	FA	FLOR	I(1,2,3-cd)P	NAP	PA	PYR
SSS-S06	0.25	05/12/96	<0.021	0.014	<0.021	0.034	0.056	0.044	0.035	0.037	0.024	<0.021	0.041	<0.021	0.028	0.049	0.033	0.038
SSS-S07.5	0.25	05/12/96	<0.0021	<0.0021	<0.0021	0.0035	0.0038	<0.0021	<0.0021	<0.0021	0.0051	<0.0021	0.0074	<0.0021	<0.0021	0.003	0.0031	0.0053
SSS-T04.8	0.25	05/12/96	<0.021	<0.021	<0.021	0.018	0.037	0.056	0.041	0.013	<0.021	<0.021	0.036	<0.021	<0.021	0.029	0.032	0.028
SSS-T05	0.25	05/12/96	<0.021	0.014	0.023	0.043	0.078	0.082	0.044	0.023	0.059	<0.021	0.082	<0.021	0.046	0.11	0.1	0.081
SSS-T06	0.25	05/12/96	<0.021	<0.021	<0.021	0.021	0.027	<0.021	0.031	<0.021	0.034	<0.021	0.047	<0.021	0.021	0.023	0.04	0.041
SSS-U05	0.25	05/12/96	0.084	0.023	0.29	0.6	0.42	0.53	<0.020	0.12	0.47	<0.020	1.6	0.11	0.14	0.16	1.1	1
SSS-U06	0.25	05/12/96	0.0043	0.0081	0.01	0.031	0.034	0.048	<0.0021	0.017	0.032	<0.0021	0.05	0.0039	0.023	0.022	0.037	0.049
SSS-V04	0.25	05/12/96	<0.022	<0.022	0.048	0.053	0.017	0.17	0.15	0.049	0.1	0.017	0.16	<0.022	0.12	0.071	0.16	0.1
SSS-V06	0.25	05/12/96	<0.0022	<0.0022	<0.0022	0.0046	0.0041	0.0061	0.0033	0.0035	0.0048	<0.0022	0.0098	<0.0022	0.003	<0.0022	0.0045	0.007
Industrial Worker Screening Level			34,190	--	170,900	2.19	0.22	2.19	--	21.9	219	0.22	22,790	22,790	2.19	22,790	--	17,090
Resident Screening Level			3,116	--	15,580	0.64	0.06	0.64	--	6.37	63.7	0.06	2,077	2,077	0.64	2,077	--	1,558

Notes and Key:
Units reported in milligrams per kilogram (mg/kg)
[light shading] Detection at or above the Resident Screening Level.
[dark shading] Detection at or above the Industrial Worker Screening Level.
NA = Not analyzed
-- = No screening level established

Table 2-4 *Total Metals Concentrations in Soil*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	Arsenic	Barium	Cadmium	Chromium	Iron	Lead	Mercury	Phosphorus	Potassium	Selenium	Silver	Sulfur
BSB-001	0.5	03/30/94	**30**	NA	NA	NA	NA	**292**	NA	NA	NA	NA	NA	NA
BSB-001	3	03/30/94	**3**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
BSB-001	5	03/30/94	**11**	NA	NA	NA	NA	**16**	NA	NA	NA	NA	NA	NA
BSB-002	0.5	04/05/94	**3**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
BSB-002	5	04/05/94	**18**	NA	NA	NA	NA	**8**	NA	NA	NA	NA	NA	NA
BSB-002	10	04/05/94	**21**	NA	NA	NA	NA	**9**	NA	NA	NA	NA	NA	NA
BSB-003	0.5	04/05/94	**2**	NA	NA	NA	NA	**9**	NA	NA	NA	NA	NA	NA
BSB-003	5	04/05/94	**6**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
BSB-003	10	04/05/94	**2**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
BSB-004	0.5	04/05/94	**2**	NA	NA	NA	NA	**7**	NA	NA	NA	NA	NA	NA
BSB-004	5	04/05/94	**2**	NA	NA	NA	NA	**5**	NA	NA	NA	NA	NA	NA
BSB-004	10	04/05/94	**3**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
BSB-005	0.5	03/30/94	**7**	NA	NA	NA	NA	**62**	NA	NA	NA	NA	NA	NA
BSB-005	4.5	03/30/94	**1**	NA	NA	NA	NA	**44**	NA	NA	NA	NA	NA	NA
BSB-005	6.5	03/30/94	**1**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
DSB-J08	0.5	03/29/94	**10**	NA	NA	NA	NA	**371**	NA	NA	NA	NA	NA	NA
DSB-J08	4.5	03/29/94	NA	NA	NA	NA	**16,900**	NA	NA	NA	**1,060**	NA	NA	NA
DSB-J08	5	03/29/94	**2**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
DSB-J08	6	03/29/94	NA	NA	NA	NA	**17,400**	NA	NA	NA	**2,740**	NA	NA	NA
DSB-J08	9.5	03/29/94	NA	NA	NA	NA	**17,700**	NA	NA	NA	**2,940**	NA	NA	NA
DSB-J08	10	03/29/94	**3**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
DSB-J08	20.5	03/29/94	NA	NA	NA	NA	**33,900**	NA	NA	NA	**2,540**	NA	NA	NA
DSB-L08	4	04/04/94	NA	NA	NA	NA	**15,200**	NA	NA	NA	**2,890**	NA	NA	NA
DSB-L08	11	04/04/94	NA	NA	NA	NA	**16,600**	NA	NA	NA	**3,000**	NA	NA	NA
DSB-M04	0.5	03/29/94	<1	**13**	<1	**6**	NA	<5	<0.2	NA	NA	<1	<2	NA
DSB-M04	2.5	03/29/94	**2**	**93**	<1	**6**	NA	**147**	<0.2	NA	NA	<1	<2	NA
DSB-M04	3.5	03/29/94	**2**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
DSB-M04	5	03/29/94	NA	NA	NA	NA	**15,400**	NA	NA	NA	**3,900**	NA	NA	NA
DSB-M04	9.5	03/29/94	NA	NA	NA	NA	**20,500**	NA	NA	NA	**4,900**	NA	NA	NA
DSB-M04	10	03/29/94	**2**	**207**	<1	**39**	NA	<5	<0.2	NA	NA	<1	<2	NA
DSB-M04	11	03/29/94	**1**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
DSB-M04	17.5	03/29/94	NA	NA	NA	NA	**16,100**	NA	NA	NA	**3,200**	NA	NA	NA
DSB-M04	22	03/29/94	NA	NA	NA	NA	**11,400**	NA	NA	NA	**2,300**	NA	NA	NA
DSB-M04	30.5	03/29/94	NA	NA	NA	NA	**31,900**	NA	NA	NA	**1,900**	NA	NA	NA
DSB-N06	0.5	03/28/94	**1**	**95**	<1	**22**	NA	**28**	<0.2	NA	NA	<1	<2	NA
DSB-N06	2.5	03/28/94	**1**	**96**	<1	**22**	NA	**28**	<0.2	NA	NA	<1	<2	NA

Table 2-4 *Total Metals Concentrations in Soil*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	Arsenic	Barium	Cadmium	Chromium	Iron	Lead	Mercury	Phosphorus	Potassium	Selenium	Silver	Sulfur
DSB-N06	3.5	03/29/94	NA	NA	NA	NA	12,600	NA	NA	NA	3,680	NA	NA	NA
DSB-N06	5	03/29/94	1	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
DSB-N06	10	03/29/94	1	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
DSB-N06	10.5	03/28/94	1	63	<1	19	NA	<5	<0.2	NA	NA	<1	<2	NA
DSB-N06	11.5	03/29/94	NA	NA	NA	NA	13,000	NA	NA	NA	3,960	NA	NA	NA
DSB-N06	30.5	03/29/94	NA	NA	NA	NA	21,000	NA	NA	NA	1,620	NA	NA	NA
DSB-V04	4.5	05/09/96	1.4	73	<1	9.5	6,000	3	<0.12	230	1,000	<1	<1	<0.00001
DSB-V04	8	05/09/96	3.1	56	<1	17	13,000	2.7	0.2	970	2,400	<1	<1	<0.00001
DSB-V04	14.5	05/09/96	5.1	39	<1	12	12,000	1.6	<0.09	870	2,100	<1	<1	<0.00001
DSB-V04	18.5	05/09/96	28	200	<1	12	11,000	15	<0.12	350	2,200	<1	<1	<0.00001
DSB-V04	21	05/09/96	2.6	110	<1	8.7	32,000	5.9	<0.1	310	1,100	<1	<1	<0.00001
MW-K05	3.5	05/11/96	3.6	NA	NA	NA	NA	10	NA	NA	NA	NA	NA	NA
MW-K05	7.5	05/11/96	7.5	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
MW-K05	10	05/11/96	1.8	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
MW-Q03	2.5	05/12/96	4.7	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
MW-Q03	6	05/12/96	3.7	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
MW-Q03	10	05/12/96	4.9	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
MW-V03	3	05/20/96	3.8	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
MW-V03	8	05/20/96	2.8	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
Pond-A-S-001		04/07/94	1	106	<1	21	NA	<20	<0.2	NA	NA	<1	<2	NA
Pond-A-S-002		04/07/94	1	80	<1	22	NA	<20	<0.2	NA	NA	<1	<2	NA
Pond-B-S-001		04/07/94	103	222	2	20	NA	65	<0.2	NA	NA	<1	<2	NA
Pond-B-S-002		04/07/94	14	200	2	41	NA	100	<0.2	NA	NA	<1	<2	NA
Pond-B-S-003		05/21/96	3.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pond-B-S-004		05/21/96	31	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SSB-I07	2	05/29/96	1	NA	NA	NA	NA	5	NA	NA	NA	NA	NA	NA
SSB-I07	6	05/29/96	3.1	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-I08	2	05/29/96	1.1	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-I08	7	05/29/96	0.49	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-J04.5	2	03/24/94	1	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-J04.5	5	03/24/94	14	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-J04.5	10	03/24/94	1	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-J06	0.5	04/05/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-J06	5	04/05/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-J06	10	04/05/94	3	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-J07	0.5	03/28/94	13	NA	NA	NA	NA	871	NA	NA	NA	NA	NA	NA

Table 2-4 *Total Metals Concentrations in Soil*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	Arsenic	Barium	Cadmium	Chromium	Iron	Lead	Mercury	Phosphorus	Potassium	Selenium	Silver	Sulfur
SSB-J07	5	03/28/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-J07	10	03/28/94	1	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-J09	2	05/29/96	1.7	NA	NA	NA	NA	10	NA	NA	NA	NA	NA	NA
SSB-J09	7	05/29/96	5.8	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-K04	2	03/22/94	92	NA	NA	NA	NA	148	NA	NA	NA	NA	NA	NA
SSB-K04	5	03/22/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-K04	10	03/22/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-K04.5	1	03/24/94	16	NA	NA	NA	NA	112	NA	NA	NA	NA	NA	NA
SSB-K04.5	5	03/24/94	6	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-K04.5	10	03/24/94	3	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-K05	1	03/22/94	13	NA	NA	NA	NA	81	NA	NA	NA	NA	NA	NA
SSB-K05	5.5	03/22/94	2	NA	NA	NA	NA	97	NA	NA	NA	NA	NA	NA
SSB-K05	10	03/22/94	1	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-K05	15	03/22/94	NA	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-K07.5	0.5	03/28/94	7	134	<1	22	<4	640	<0.2	NA	<400	<1	<2	NA
SSB-K07.5	2	03/28/94	3	NA	NA	NA	NA	299	NA	NA	NA	NA	NA	NA
SSB-K07.5	5	03/28/94	4	NA	NA	NA	NA	288	NA	NA	NA	NA	NA	NA
SSB-K07.5	5.5	03/28/94	4	114	<1	28	<4	109	<0.2	NA	<400	<1	<2	NA
SSB-K07.5	10	03/28/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-K07.5	10.5	03/28/94	2	106	<1	29	<4	87.2	<0.2	NA	<400	<1	<2	NA
SSB-K07.5	15	03/28/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-K09	2	05/29/96	2	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-K09	7	05/29/96	2.3	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-L04.5	1	03/23/94	41	NA	NA	NA	NA	12	NA	NA	NA	NA	NA	NA
SSB-L04.5	5	03/23/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-L04.5	10	03/23/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-L05	2	03/28/94	8	NA	NA	NA	NA	139	NA	NA	NA	NA	NA	NA
SSB-L05	4	03/24/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-L05	5.5	03/24/94	NA	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-L05	6	03/24/94	3	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-L05	10	03/24/94	1	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-L06	0.5	03/28/94	7	NA	NA	NA	NA	204	NA	NA	NA	NA	NA	NA
SSB-L06	5	03/28/94	3	NA	NA	NA	NA	5	NA	NA	NA	NA	NA	NA
SSB-L06	10	03/28/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-L07	0.5	03/28/94	10	NA	NA	NA	NA	337	NA	NA	NA	NA	NA	NA
SSB-L07	5	03/28/94	12	NA	NA	NA	NA	168	NA	NA	NA	NA	NA	NA

Table 2-4 *Total Metals Concentrations in Soil*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	Arsenic	Barium	Cadmium	Chromium	Iron	Lead	Mercury	Phosphorus	Potassium	Selenium	Silver	Sulfur
SSB-L07	10	03/28/94	**3**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-L07	15	03/28/94	**6**	NA	NA	NA	NA	**11**	NA	NA	NA	NA	NA	NA
SSB-L09	2	05/28/96	**2.1**	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-L09	6.5	05/28/96	**1.6**	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-L10	2	05/29/96	**1.1**	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-L10	7	05/29/96	**0.71**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M03	2.5	05/11/96	**1.4**	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-M03	7.5	05/11/96	**0.51**	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-M04	0.5	03/22/94	**7**	NA	NA	NA	NA	**158**	NA	NA	NA	NA	NA	NA
SSB-M04	1.5	03/22/94	**21**	NA	NA	NA	NA	**248**	NA	NA	NA	NA	NA	NA
SSB-M04	2	03/22/94	**2**	NA	NA	NA	NA	**8**	NA	NA	NA	NA	NA	NA
SSB-M04	5	03/22/94	**1**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M04	6	03/22/94	**2**	NA	NA	NA	NA	**35**	NA	NA	NA	NA	NA	NA
SSB-M04	10	03/22/94	**3**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M04.5	1	03/23/94	**5**	NA	NA	NA	NA	**84**	NA	NA	NA	NA	NA	NA
SSB-M04.5	4.5	03/23/94	**2**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M04.5	10	03/23/94	**1**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M05	1	03/24/94	**2**	NA	NA	NA	NA	**132**	NA	NA	NA	NA	NA	NA
SSB-M05	2	03/24/94	**3**	NA	NA	NA	NA	**17**	NA	NA	NA	NA	NA	NA
SSB-M05	5	03/24/94	**2**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M05	8	03/17/94	NA	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M05	10	03/17/94	**2**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M06	0.5	03/28/94	**3**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M06	5	03/28/94	**2**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M06	10	03/28/94	**3**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M08	5	03/28/94	**3**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M08	10	03/28/94	**2**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M08	11.8	03/28/94	**3**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-M09	2	05/29/96	**1.7**	NA	NA	NA	NA	**5**	NA	NA	NA	NA	NA	NA
SSB-M09	7	05/29/96	**0.7**	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-N04.5	1	03/23/94	**2**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-N04.5	5	03/23/94	**2**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-N04.5	10	03/23/94	**2**	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-N05	2	03/24/94	**2**	NA	NA	NA	NA	**169**	NA	NA	NA	NA	NA	NA
SSB-N05	5	03/24/94	**4**	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA
SSB-N05	10	03/24/94	**1**	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA

Table 2-4 *Total Metals Concentrations in Soil*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	Arsenic	Barium	Cadmium	Chromium	Iron	Lead	Mercury	Phosphorus	Potassium	Selenium	Silver	Sulfur
SSB-O04.5	0.5	03/22/94	NA	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-O04.5	5	03/28/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-O05	0.5	03/24/94	5	NA	NA	NA	NA	236	NA	NA	NA	NA	NA	NA
SSB-O05	4	03/24/94	1	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA
SSB-O05	6	03/24/94	4	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA
SSB-O05	10	03/24/94	2	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA
SSB-O06	0.5	03/30/94	13	NA	NA	NA	NA	755	NA	NA	NA	NA	NA	NA
SSB-O06	5	03/30/94	2	NA	NA	NA	NA	21	NA	NA	NA	NA	NA	NA
SSB-O06	12	03/30/94	5	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-O07	0.5	03/25/94	5	NA	NA	NA	NA	780	NA	NA	NA	NA	NA	NA
SSB-O07	5	03/25/94	5	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA
SSB-O07	10	03/25/94	3	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA
SSB-O07	12	03/25/94	2	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA
SSB-P04	2	03/22/94	<1	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-P04	5	03/22/94	1	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-P04	10	03/22/94	4	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-P04	15	03/22/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-P05	0.5	03/25/94	4	NA	NA	NA	NA	813	NA	NA	NA	NA	NA	NA
SSB-P05	5	03/25/94	2	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA
SSB-P05	9	03/25/94	1	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA
SSB-P06	0.5	03/30/94	<1	NA	NA	NA	NA	33	NA	NA	NA	NA	NA	NA
SSB-P06	5	03/30/94	2	NA	NA	NA	NA	<5	NA	NA	NA	NA	NA	NA
SSB-P06	7.5	03/30/94	2	80	<1	20	NA	<5	<0.2	NA	NA	<1	<2	NA
SSB-P06	10	03/30/94	3	108	<1	16	NA	<5	<0.2	NA	NA	<1	<2	NA
SSB-P06	13.5	03/30/94	2	88	<1	30	NA	<5	<0.2	NA	NA	<1	<2	NA
SSB-P06	14	03/30/94	5	NA	NA	NA	NA	<5	NA	NA	NA	0.19	NA	NA
SSB-P08.3	2.5	05/11/96	NA	NA	NA	NA	NA	15	NA	NA	NA	<0.1	NA	NA
SSB-P08.3	5	05/11/96	0.86	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-P08.3	25	05/11/96	2.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SSB-Q06	0.5	03/25/94	6	NA	NA	NA	NA	256	NA	NA	NA	NA	NA	NA
SSB-Q06	2	03/25/94	2	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA
SSB-Q06	5	03/25/94	2	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA
SSB-Q06	10	03/25/94	2	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA
SSB-Q07	0.5	03/25/94	16	NA	NA	NA	NA	451	NA	NA	NA	NA	NA	NA
SSB-Q07	5	03/25/94	13	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA
SSB-Q07	10	03/25/94	3	NA	NA	NA	NA	<15	NA	NA	NA	NA	NA	NA

Table 2-4 *Total Metals Concentrations in Soil*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	Arsenic	Barium	Cadmium	Chromium	Iron	Lead	Mercury	Phosphorus	Potassium	Selenium	Silver	Sulfur
SSB-Q08.1	2.5	05/11/96	2.2	NA	NA	NA	NA	5	NA	NA	NA	NA	NA	NA
SSB-Q08.1	4.5	05/11/96	1.3	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-Q08.1	9	05/11/96	0.79	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-R06	2.5	05/10/96	3.2	68	<0.1	14	NA	5.2	<0.11	NA	NA	NA	<0.1	NA
SSB-R06	5	05/10/96	3.9	230	<0.1	14	NA	2.4	0.19	NA	NA	NA	<0.1	NA
SSB-R06	7.5	05/10/96	3.8	66	<0.11	16	NA	1.6	0.26	NA	NA	<0.11	<0.11	NA
SSB-R06	12	05/10/96	2.2	62	<0.11	17	NA	2.6	0.24	NA	NA	<0.11	<0.11	NA
SSB-S05	4.5	05/13/96	1.8	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-S05	8	05/13/96	0.89	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-S06	2.5	05/10/96	2.3	NA	NA	NA	NA	25	NA	NA	NA	NA	NA	NA
SSB-S06	5	05/10/96	0.77	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-S06	9.5	05/10/96	1.7	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-S06	12.5	05/10/96	3.5	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-T04.8	2.5	05/10/96	1.5	100	<0.12	15	NA	4.2	<0.093	NA	NA	<0.12	<0.12	NA
SSB-T04.8	7.5	05/10/96	2	210	<0.12	19	NA	3.2	0.14	NA	NA	<0.12	<0.12	NA
SSB-T04.8	12	05/10/96	1.5	40	<0.11	13	NA	1.1	0.17	NA	NA	<0.11	<0.11	NA
SSB-U05	3.5	05/13/96	2.1	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-U05	5	05/13/96	2.5	NA	NA	NA	NA	5	NA	NA	NA	NA	NA	NA
SSB-U05	8	05/13/96	0.97	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-U05	11	05/13/96	3	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-U06	5	05/10/96	1.9	NA	NA	NA	NA	40	NA	NA	NA	NA	NA	NA
SSB-U06	7	05/10/96	1.5	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSB-V06	2.5	05/10/96	5.4	NA	NA	NA	NA	210	NA	NA	NA	NA	NA	NA
SSB-V06	5	05/10/96	4	NA	NA	NA	NA	<1	NA	NA	NA	NA	NA	NA
SSS-K03.5	0.25	05/13/96	8.8	110	1.5	22	NA	230	0.13	NA	NA	0.12	0.21	NA
SSS-K04.5	0.25	05/13/96	8.2	48	0.55	18	NA	24	0.15	NA	NA	0.44	<0.1	NA
SSS-K08	0.25	05/14/96	4	87	0.18	13	NA	100	0.21	NA	NA	<0.096	0.16	NA
SSS-L08	0.25	05/14/96	3	140	0.39	16	NA	240	0.24	NA	NA	<0.12	0.13	NA
SSS-M04.5	0.25	05/13/96	9	41	0.29	20	NA	39	0.098	NA	NA	0.44	0.1	NA
SSS-N06	0.25	05/13/96	1.4	93	0.34	15	NA	66	<0.086	NA	NA	<0.1	0.12	NA
SSS-O04.5	0.25	05/13/96	NA	NA	NA	NA	NA		0.22	NA	NA	NA	NA	NA
SSS-O07	0.25	05/13/96	11	78	0.48	14	NA	250	0.15	NA	NA	0.13	0.13	NA
SSS-P04	0.25	05/13/96	7.6	99	1.1	18	NA	180	0.25	NA	NA	<0.091	0.23	NA
SSS-P05	0.25	05/13/96	8.6	89	0.6	15	NA	140	0.098	NA	NA	0.12	<0.093	NA
SSS-P07	0.25	05/13/96	8.9	89	0.41	14	NA	1,000	3.3	NA	NA	<0.093	<0.093	NA
SSS-P08	0.25	05/13/96	3.7	140	0.24	18	NA	97	0.15	NA	NA	<0.11	<0.11	NA

Table 2-4 ***Total Metals Concentrations in Soil***
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample Location	Sample Depth	Sample Date	Arsenic	Barium	Cadmium	Chromium	Iron	Lead	Mercury	Phosphorus	Potassium	Selenium	Silver	Sulfur
SSS-Q08	0.25	05/14/96	9.8	100	0.25	15	NA	310	0.39	NA	NA	0.1	<0.1	NA
SSS-R06	0.25	05/12/96	2.3	85	0.35	12	NA	130	<0.082	NA	NA	<0.1	<0.1	NA
SSS-R07	0.25	05/12/96	13	88	0.38	14	NA	120	0.088	NA	NA	<0.099	<0.099	NA
SSS-S05	0.25	05/12/96	4.7	110	1	16	NA	400	0.52	NA	NA	<0.09	0.16	NA
SSS-S06	0.25	05/12/96	4.5	110	0.64	14	NA	1,500	0.12	NA	NA	<0.096	0.23	NA
SSS-S07.5	0.25	05/12/96	2.4	100	<0.1	14	NA	6.2	<0.096	NA	NA	<0.1	<0.1	NA
SSS-T04.8	0.25	05/12/96	11	140	2	30	NA	340	0.11	NA	NA	<0.092	0.17	NA
SSS-T05	0.25	05/12/96	15	220	2.5	26	NA	2,300	0.66	NA	NA	<0.095	0.82	NA
SSS-T06	0.25	05/12/96	9.1	140	0.69	15	NA	1,600	0.16	NA	NA	<0.1	0.29	NA
SSS-U05	0.25	05/12/96	16	170	3.7	28	NA	1,000	3	NA	NA	0.22	0.48	NA
SSS-U06	0.25	05/12/96	3.5	66	0.32	12	NA	190	0.098	NA	NA	<0.099	<0.099	NA
SSS-V04	0.25	05/12/96	38	160	5.5	22	NA	580	0.27	NA	NA	0.18	1.3	NA
SSS-V06	0.25	05/12/96	7.1	NA	0.12	12	NA	52	<0.09	NA	NA	<0.11	<0.11	NA
Industrial Worker Screening Level			30	15,270	605	86,370	--	2,000	186	--	--	7,599	3,504	--
Resident Screening Level			30	2,161	34.5	15,140	--	200	16.2	--	--	366	284	--

Notes and Key:
Units reported in milligrams per kilogram (mg/kg)
NA = Not analyzed
[light shading] Detection at or above the Resident Screening Level.
[dark shading] Detection at or above the Industrial Worker Screening Level.
-- = No screening level established.

Table 2-5 *Total Petroleum Hydrocarbon Concentrations in Ground Water*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

			Total Petroleum Hydrocarbons (µg/L)		
Sample ID	Date Collected	Aliquot	Diesel Fuel	Gasoline	Unknown Hydrocarbon Mixture
Former Car Repair Shed Area					
H-R04	03/17/94	SA	50U[a]	NA	NA
	03/17/94	EB	180	NA	NA
H-V04	05/07/96	SA	NA	2,960NJT	NA
	05/07/96	LD	NA	2,980NJT	NA
H-V05	05/09/96	SA	NA	308NJT	NA
MW-V03	06/23/97	SA	<50	<50	52
	07/17/97	SA	<50	<50	53
Locomotive Maintenance and Service Area					
H-J04	03/18/94	SA	806	NA	NA
H-J06	03/21/94	SA	247	NA	NA
H-J08	03/20/94	SA	228	NA	NA
H-L06	03/18/94	SA	2,190	NA	NA
H-L07	03/20/94	SA	762	NA	NA
H-M06	03/17/94	SA	650	NA	NA
H-N04	03/18/94	SA	317U	NA	NA
	03/18/94	FD	232	NA	NA
	03/18/94	EB	160	NA	NA
H-N06	03/17/94	SA	13,200	NA	NA
H-N08	03/21/94	SA	426	NA	NA
	03/21/94	FD	426	NA	NA
H-O05	03/19/94	SA	157	NA	NA
H-P04	03/18/94	SA	90	NA	NA
H-Q06	03/19/94	SA	613	NA	NA
MW-K05	05/23/96	SA	<50	NA	<50
	06/23/97	SA	<50	NA	240
	09/18/97	SA	<50	NA	240
	09/18/97	FD	<50	NA	240
	12/09/97	SA	<50	<50	220
	12/09/97	FD	<50	<50	230
	03/12/98	SA	<50	NA	240
	03/12/98	FD	<50	NA	250
MW-K08	04/15/94	SA	5,350	NA	NA
	04/15/94	FD	3,810	NA	NA
	02/22/95	SA	<160	NA	2,600
	06/28/95	SA	<100	NA	1,400
	02/28/96	SA	<150	NA	1,400
	02/28/96	FD	<290	NA	1,600
	05/24/96	SA	173J	NA	173
	06/24/97	SA	<200	NA	2,200
	09/17/97	SA	<50	NA	2,300
	12/09/97	SA	<50	NA	2,300
	03/12/98	SA	<250	NA	2,400

Table 2-5 *Total Petroleum Hydrocarbon Concentrations in Ground Water*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample ID	Date Collected	Aliquot	Total Petroleum Hydrocarbons (µg/L) Diesel Fuel	Gasoline	Unknown Hydrocarbon Mixture
Locomotive Maintenance and Service Area (continued)					
MW-M03	04/14/94	SA	193	NA	NA
	02/24/95	SA	<50	NA	73
	02/24/95	FD	<50	NA	73
	06/28/95	SA	<50	NA	92
	12/09/97	SA	<50	NA	57
MW-N08	04/15/94	SA	210	NA	NA
	02/23/95	SA	<50	NA	190
	06/28/95	SA	<50	NA	510
	06/28/95	FD	<50	NA	670
	02/28/96	SA	<50	NA	73
	06/24/97	SA	<50	NA	73
	09/18/97	SA	<50	NA	62
	12/09/97	SA	<50	NA	88
	03/12/98	SA	<50	NA	63
MW-P07	04/15/94	SA	329	NA	NA
	02/23/95	SA	<50	NA	54
	06/28/95	SA	<50	NA	77
	02/28/96	SA	<50	NA	59
	06/23/97	SA	<50	NA	67
	09/17/97	SA	<50	NA	85
	12/09/97	SA	<50	NA	66
	03/11/98	SA	<50	NA	58
Ponds					
Pond-A-001	04/06/94	EB	51	NA	NA
Pond-A-SW-001	04/06/94	SA	2,020	NA	NA
	04/06/94	FD	2,190	NA	NA
Pond-A-SW-002	04/06/94	SA	2,370	NA	NA
Pond-A-SW-003	04/06/94	SA	1,200	NA	NA
Pond-B-SW-001	04/06/94	SA	7,300	NA	NA
Pond-B-SW-002	04/06/94	SA	5,500	NA	NA

Notes and Key:

a = Non-detect value due to equipment blank concentration.

µg/L = Micrograms per liter

SA = Sample

EB = Equipment Blank

LD = Laboratory duplicate

FD = Field duplicate

U = Undetected at the laboratory method reporting limit shown.

J = Analyte was positively identified. Approximate concentration.

NA = Not analyzed.

NJT = 'The product is tentatively identified as weathered gasoline with peaks extending into the diesel range.

Table 2-6 Volatile Organic Compound Concentrations in Ground Water
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample ID	Date Collected	Aliquot	Volatile Organic Compounds (µg/L)					
			Benzene	Chloroform	Ethylbenzene	Toluene	Total Xylenes	MTBE
Former Car Repair Shed Area								
H-V04	05/07/96	SA	**224J**	<1.0	**88J**	**31J**	**75J**	NA
H2-V05	05/09/96	SA	**7.0J**	<1.0	**4.0J**	**1.0J**	**6.0J**	NA
MW-V03	06/23/96	SA	<1	NA	<1	<1	<2	**1,100**
	06/23/97	SA	<25	NA	<25	<25	<50	**1,500**
	06/23/97	FD	<25	NA	<25	<25	<50	**1,500**
	09/17/97	SA	<25	NA	<25	<25	<50	**2,100**
	12/09/97	SA	<0.5	NA	<0.5	<0.5	<1	**2,400**
	03/12/98	SA	<25	NA	<25	<25	<50	**1,800**
Locomotive Maintenance and Service Area								
MW-K08	04/15/94	SA	<0.50	**0.5**	<1.0	<1.0	<1.0	NA
	06/28/95	SA	<0.50	NA	<0.50	**1.3**	<1.0	NA
MW-M03	04/14/94	SA	<0.50	<1.0	<1.0	<1.0	<1.0	NA
	04/14/94	EB	<0.50	**2.40**[a]	<1.0	<1.0	<1.0	NA
	02/24/95	SA	<0.50	NA	<0.50	**1.1**	<1.0	NA
	02/24/95	FD	<0.50	NA	<0.50	**1.5**	<1.0	NA
	06/28/95	SA	<0.50	NA	<0.50	**0.94**	<1.0	NA
MW-N08	04/15/94	SA	<0.50	**7.8**	<1.0	<1.0	<1.0	NA
	02/23/95	SA	<0.50	NA	<0.50	**1.9**	<1.0	NA
	06/28/95	SA	<0.50	NA	<0.50	**1.0**	<1.0	NA
	06/28/95	FD	<0.50	NA	<0.50	**0.96**	<1.0	NA
MW-P07	04/15/94	SA	<0.50	**0.9**	<1.0	<1.0	<1.0	NA
	06/28/95	SA	<0.50	NA	<0.50	**0.88**	<1.0	NA
Ponds								
Pond-A-001	04/06/94	EB	<0.50	**2.5**	<1.0	<1.0	<1.0	NA
Pond-A-SW-001	04/06/94	SA	<0.50	**2.5**	<1.0	<1.0	<1.0	NA
USEPA MCLs			5	100	700	1,000	10,000	NR

Notes and Key:

a = Analyte is undetected due to detection in equipment blank.
MTBE = Methyl tert-butyl ether
NA = Not analyzed
NR = Not regulated
µg/L = Micrograms per liter
SA = Sample
EB = Equipment Blank
FD = Field duplicate
J = Analyte was positively identified. Approximate concentration.
USEPA MCLs = United States Environmental Protection Agency Maximum Contaminant Levels for drinking water.

Table 2-7 *Polynuclear Aromatic Hydrocarbon Concentrations in Ground Water*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample ID	Date Collected	Aliquot	Polynuclear Aromatic Hydrocarbons (µg/L) 2-Methylnaphthalene	Acenaphthene	Anthracene	Benzo(a)pyrene	Benzo(g,h,i)perylene	Fluorene	Naphthalene	Phenanthrene	Pyrene
Former Car Repair Shed Area											
H-V04	05/07/96	SA	60	<1.0	<1.0	<1.0	<1.0	<1.0	220	<1.0	<1.0
MW-V03	05/23/96	SA	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	0.03J	<0.09	0.42
Locomotive Maintenance and Service Area											
H-J08	03/20/94	SA	NA	<0.10	<0.10	0.1	0.2	0.2	<0.10	0.3	0.2
MW-K08	11/09/95	SA	NA	<0.47	<0.05	<0.05	<0.09	<0.09	<0.47	<0.05	0.23
RW-006	05/21/96	SA	2,400	380	280	<200	<200	720	<200	1,500	180.0J
Ponds											
Pond-A-SW-003	04/06/94	SA	NA	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.2	<0.10
Off-Property Area											
H-I08	05/28/96	SA	<1.0	<0.12	<0.12	<0.12	<0.12	<0.12	0.18	<0.12	<0.12
USEPA MCLs			NE	NE	NE	0.2	NE	NE	NE	NE	NE

Notes and Key:

µg/L = Micrograms per liter

NA = Not analyzed

NE = Not established

SA = Sample

J = Analyte was positively identified. Approximate concentration.

USEPA MCLs = United States Environmental Protection Agency Maximum Contaminant Levels for drinking water.

Table 2-8 *Total Metals Concentrations in Ground Water*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample ID	Date Collected	Aliquot	Total Metals (µg/L)				
			Arsenic	Barium	Chromium	Lead	Mercury
Former Car Repair Shed Area							
H-R04	03/17/94	SA	6.0	234	43	<2.0	<0.50
H-T03	05/09/96	SA	NA	760	6.9	<1.0	0.84
	05/09/96	FD	NA	650	4.3	<1.0	1.1
H-T05	05/08/96	SA	16	340	59	360	4.6
	05/08/96	FD	20	410	81	53	5.7
H-V04	05/07/96	SA	59	1,140	102	54	1.1
MW-V03[a]	05/23/96	SA	19	270	2.7	3.9	<0.20
	06/23/97	SA	21	NA	9.2	<5.0	NA
	06/23/97	FD	21	NA	11	<5.0	NA
	12/09/97	SA	28	NA	15	<5.0	NA
	03/12/98	SA	35	NA	29	7.8	NA
Locomotive Maintenance and Service Area							
H-J08	03/20/94	SA	21	293	58	1,270	<0.50
H-L06	03/18/94	SA	10	NA	NA	<2.0	NA
H-L07	03/20/94	SA	24	1,920	223	94	1.6
H-O06	03/19/94	SA	28	1,130	288	31	4.0
	03/19/94	FD	29	1,200	293	34	3.5
H-P06	03/19/94	SA	28	NA	NA	31	NA
MW-K05	05/23/96	SA	17	NA	1.7	3.0	NA
	05/23/96	FD	17	NA	1.3	2.3	NA
	06/23/97	SA	14	NA	4.7	<5.0	NA
	12/09/97	SA	25	NA	10	<5.0	NA
	12/09/97	FD	27	NA	12	<5.0	NA
	03/12/98	SA	22	NA	14	42	NA
	03/12/98	FD	22	NA	13	39	NA
MW-K08	04/15/94	SA	<5.0	723	66	<2.0	<0.50
	04/15/94	FD	<5.0	782	83	<2.0	<0.50
	02/22/95	SA	<5.0	NA	1.0	<5.0	NA
	06/28/95	SA	<5.0	NA	1.0	<5.0	NA
	11/09/95	SA	<5.0	NA	1.4	<5.0	NA
MW-M03[a]	04/14/94	SA	<5.0	491	102	23	<0.50
	02/24/95	SA	<5.0	NA	6.8	<5.0	NA
	02/24/95	FD	<5.0	NA	9.1	<5.0	NA
	06/28/95	SA	<5.0	NA	1.0	<5.0	NA
	11/09/95	SA	<5.0	NA	11	11	NA

Table 2-8 *Total Metals Concentrations in Ground Water*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Sample ID	Date Collected	Aliquot	Total Metals (µg/L)				
			Arsenic	Barium	Chromium	Lead	Mercury
Locomotive Maintenance and Service Area (continued)							
MW-M03[a]	02/28/96	SA	NA	NA	**5.3**	NA	NA
MW-N08	04/15/94	SA	**6.0**	**662**	**85**	**30**	<0.50
	02/23/95	SA	<5.0	NA	**34**	**11**	NA
	06/28/95	SA	<5.0	NA	**2.1**	<5.0	NA
	06/28/95	FD	<5.0	NA	**1.1**	<5.0	NA
	11/09/95	SA	<5.0	NA	**1.3**	<5.0	NA
MW-P07	04/15/94	SA	**6.0**	**217**	**11**	<2.0	<0.50
	02/23/95	SA	**6.7**	NA	**2.5**	<5.0	NA
	06/28/95	SA	**6.2**	NA	<1.0	<5.0	NA
	11/08/95	SA	**7.2**	NA	**1.8**	<5.0	NA
	11/08/95	FD	**6.0**	NA	<1.0	<5.0	NA
	02/28/96	SA	**5.2**	NA	<1.0	NA	NA
RW-006	05/21/96	SA	**65**	**460**	**2.2**	**120**	<0.80
Ponds							
Pond-A-SW-001	04/06/94	SA	<5.0	**57**	<5.0	<2.0	<0.50
	04/06/94	FD	<5.0	**58**	<5.0	<2.0	<0.50
Pond-A-SW-002	04/06/94	SA	<5.0	**58**	<5.0	<2.0	<0.50
Pond-A-SW-003	04/06/94	SA	<5.0	**58**	<5.0	<2.0	<0.50
Pond-B-SW-001	04/06/94	SA	**7.0**	**69**	<5.0	<2.0	<0.50
Pond-B-SW-002	04/06/94	SA	**14**	**92**	<5.0	**7.0**	<0.50
NAT-Pond-SS-001	05/01/97	SA	**14**	<100	<2.0	<2.0	<0.50
NAT-Pond-SS-002	05/01/97	SA	**18**	<100	<0.20	<2.0	<0.50
Off-Property Area							
H-I08	05/28/96	SA	**3.2**	**270**	**21**	**8.0**	**1.2**
USEPA MCLs			50	2,000	100	15	–

Notes and Key:

a = Well considered background.

µg/L = Micrograms per liter

NA = Not analyzed

SA = Sample

FD = Field duplicate

USEPA MCLs = United States Environmental Protection Agency Maximum Contaminant Levels for drinking water.

Table 4-1 *Summary of Soil Remediation Alternatives*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Technologies and Response Actions Retained for Further Consideration	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
No Action	X				
Common Elements*		X	X	X	X
Engineered Soil Cap over all areas exceeding goals		X			
Excavation, stabilization via asphalt incorporation, and use asphalt on site during redevelopment				X	
Excavation with on-site enclosure of soils beneath asphalt roadways during redevelopment					X
Excavation with off-site treatment and/or disposal			X		X

Common Elements include:
- removal of oil/water separator plus affected soils and concrete tank saddles;
- abandon oil collection culverts and recovery wells, piezometers, free product observation probes, and monitoring wells;
- prepare Ponds A and B for backfilling;
- excavate Bunker C area in former landfill and dispose off site; and
- remove ballast and residual petroleum associated with the former drip pad and dispose off site.

Table 5-1 Summary of Costs Associated with Each Alternative
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Alternative	Description	Direct and Indirect Capital Costs	Annual O&M	NPV of 30-Year Annual O&M	Total
Alternative 1	No Action	$0	$0	$0	$0
Alternative 2	Soil Cap, Deed Restriction, Common Tasks	$1,099,400	$10,500	$300,000	$1,399,400
Alternative 3	Excavation with Off-site Disposal and Common Tasks	$878,000	$0	$0	$878,000
Alternative 4	Excavation, Asphalt Incorporation, and Common Tasks	$975,000	$0	$0	$975,000
Alternative 5	Excavation, Off-site Disposal, plus On-site Enclosure of Some Soils Beneath Road(s), Deed restriction and Common Tasks	$1,016,000	$3,500	$100,000	$1,116,000

Notes and Key:

NPV = Net present value of annual O&M Costs assuming 5% annual discount rate.

O&M = Operation and Maintenance

Refer to Tables 3 through 6 for detailed cost information on each alternative.

Table 5-2 *Alternative 2 Cost Estimate*
Soil Cap Over Affected Areas
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Description	QUANTITY		COST	
	Number	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COST				
Placement and Compaction of Soil Cap				
Surveying to outline impacted areas	2	day	$1,200	$2,400
Soil sampling	100	sample	$150	$15,000
Breakup, remove and dispose concrete	2,010	CY	$40	$80,400
Site preparation (clearing, grubbing, and disposal)	1,000	CY	$15	$15,000
Placement of soil cap (materials, placement, and compaction)	20,000	CY	$17	$340,000
Compaction testing	20	day	$1,000	$20,000
Top soil - six inches (materials, placement, compaction, seeding)	5,000	CY	$17	$85,000
Final surveying and documentation	1	lump sum	$6,000	$6,000
SUBTOTAL				$563,800
Tasks Common to All Action Alternatives				
Abandon monitoring wells, piezometers, free-product probes and collection culverts	1	lump sum	$8,000	$8,000
Drain, clear and grub Ponds A & B, lay rock and fabric prior to backfilling	1	lump sum	$12,000	$12,000
Drain and remove oil/water separator, remove tank saddles	1	lump sum	$9,000	$9,000
Excavate and stockpile Bunker C soils	400	CY	$15	$6,000
Remove ballast and oily soil next to former drip pad	130	CY	$15	$1,950
Soil sampling and analysis (profiling and confirmation)	15	sample	$200	$3,000
Fill and compact Ponds A&B, Bunker C area, and former drip slab	3,000	CY	$17	$51,000
Dispose Bunker C soils and oily soils at ECDC	800	ton	$20	$16,000
SUBTOTAL				$107,000
Labor				
Construction oversight, Technicians, and expenses (15% of Capitol Costs)				$100,620
TOTAL DIRECT CAPITAL COST				$771,420
Administrative and Indirect Capital Costs				
DEQ Oversight	1	lump sum	$10,000	$10,000
Engineering, procurement, construction management, and administrative costs (10% of Direct costs)				$77,142
Health and Safety (2.5% of direct costs)				$19,286
Project management (5% of direct costs)				$38,571
TOTAL INDIRECT CAPITAL COSTS				$145,000
Annual Operation and Maintenance (O&M)				
Cap inspection	1	lump sum	$5,000	$5,000
Cap maintenance	1	lump sum	$5,000	$5,000
Periodic ODEQ Review	1	lump sum	$500	$500
ANNUAL O&M COSTS				$10,500
30-YEAR NET PRESENT VALUE OF ANNUAL O&M COSTS				$300,000
TOTAL CAPITAL (DIRECT AND INDIRECT)				$916,400
General Contingency (20% of Direct and Indirect Capital Costs)				$183,000
TOTAL COST OF ALTERNATIVE (PRESENT WORTH)				$1,399,400

Key:
CY = cubic yard

Assumptions
Deed restriction required to document long-term presence of affected soils beneath cap
Soil cap placed over all areas with residential cleanup goal exceedances
Soil cap placed in 4-inch lifts to a total thickness of two feet
20 x 20 foot cap required for single point exceedances. Actual surface area would be defined through field sampling.
1.5 tons per cubic yard of soil
2 tons per cubic yard of concrete
Bunker C and oily soils transported to ECDC via rail, cost not included
25% added to imported soil to account for fluff and compaction factors

Table 5-3 *Alternative 3 Cost Estimate*
Excavation with Off-Site Disposal
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Description	QUANTITY		COST	
	Number	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COST				
Excavation, Stockpiling, Backfilling, Loading Soil for Off-Haul				
Surveying to Outline Impacted Areas	2	day	$1,200	$2,400
Locate and Mark Burried Utilities	1	lump sum	$700	$700
Breakup, remove and dispose concrete	2,010	CY	$40	$80,400
Excavate and load soils above residential goals	5,600	CY	$15	$84,000
Dispose soils above residential goals at ECDC	8,400	ton	$20	$168,000
Soil sampling and analysis (profiling and confirmation)	110	sample	$200	$22,000
Import clean fill, place and compact*	3,750	CY	$17	$63,750
Compaction Testing	5	day	$1,000	$5,000
Final Surveying and Documentation	1	lump sum	$2,000	$2,000
SUBTOTAL				$428,300
Tasks Common to All Action Alternatives				
Abandon monitoring wells, piezometers, free-product probes and collection culverts	1	lump sum	$8,000	$8,000
Drain, clear and grub Ponds A & B, lay rock and fabric prior to backfilling	1	lump sum	$12,000	$12,000
Drain and remove oil/water separator, remove tank saddles and affected soils	1	lump sum	$9,000	$9,000
Excavate and stockpile Bunker C soils	400	CY	$15	$6,000
Remove ballast and oily soil next to former drip pad	130	CY	$15	$1,950
Soil sampling and analysis (profiling and confirmation)	15	sample	$200	$3,000
Import clean fill, place, and compact (Ponds A and B, Bunker C area, and former drip slab)	3,000	CY	$17	$51,000
Dispose Bunker C soils and oily soils at ECDC	800	ton	$20	$16,000
SUBTOTAL				$107,000
Labor				
Construction oversight, Technicians, and expenses (15% of Capitol Costs)				$80,295
TOTAL DIRECT CAPITAL COST				$615,600
Administrative and Indirect Capital Costs				
Engineering, procurement, construction management, and administrative (10% of Direct Capital Cc	1	lump sum		$61,560
ODEQ Oversight	1	lump sum		$8,000
Health and Safety Contingency (2.5% of Direct Capital Costs)	1	lump sum		$15,390
Project Management (5% of Direct Capital Costs)	1	lump sum		$30,780
INDIRECT CAPITAL COST				$115,700
TOTAL CAPITAL AND O&M COST (DIRECT AND INDIRECT)				$731,300
General Contingency (20% of Direct and Indirect Capital Costs)				$146,260
				$878,000

Key:
CY = cubic yard

Assumptions
10 x 10 foot surface area used to determine soil volumes for single point exceedances. Actual volumes will be defined through field sampling.
* All excavations that extend 6 inches bgs or less will not be backfilled
1.5 tons per cubic yard of soil
2 tons per cubic yard of concrete
All soils transported to ECDC via rail, cost not included
25% added to imported fill needs to accout for fluff and compaction factors

Table 5-4 *Alternative 4 Cost Estimate*
Excavation with Asphalt Incorporation
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Description	QUANTITY		COST	
	Number	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COST				
Excavation and Asphalt Incorporation				
Surveying to Outline Impacted Areas	2	day	$1,200	$2,400
Locate and Mark Burried Utilities	1	lump sum	$700	$700
Breakup, remove and dispose concrete	2,010	CY	$40	$80,400
Mobe and demove asphalt incorporation equipment	1	lump sum	$5,000	$5,000
Bench scale testing on soils	1	lump sum	$2,000	$2,000
Excavate and stockpile soils above industrial goals	5,600	CY	$15	$84,000
Treat via asphalt incorporation and place on site	5,600	CY	$40	$224,000
Import clean fill, place and compact*	3,750	CY	$17	$63,750
Soil sampling and analysis (confirmation)	110	sample	$200	$22,000
Compaction testing	2	day	$1,000	$2,000
Final surveying and documentation	1	lump sum	$2,000	$2,000
SUBTOTAL				$488,300
Tasks Common to All Action Alternatives				
Abandon monitoring wells, piezometers, free-product probes and collection culverts	1	lump sum	$8,000	$8,000
Drain, clear and grub Ponds A & B, lay rock and fabric prior to backfilling	1	lump sum	$12,000	$12,000
Drain and remove oil/water separator, remove tank saddles	1	lump sum	$9,000	$9,000
Excavate and stockpile Bunker C soils	400	CY	$15	$6,000
Remove ballast and oily soil next to former drip pad	130	CY	$15	$1,950
Soil sampling and analysis (profiling and confirmation)	15	sample	$200	$3,000
Fill and compact Ponds A&B, Bunker C area, and former drip slab*	3,000	CY	$17	$51,000
Dispose Bunker C soils and oily soils at ECDC	800	ton	$20	$16,000
SUBTOTAL				$107,000
Labor				
Construction oversight, Technicians, and expenses (15% of Capitol Costs)				$89,295
TOTAL DIRECT CAPITAL COST				$684,595
Administrative and Indirect Capital Costs				
DEQ Oversight	1	lump sum	$8,000	$8,000
Engineering, procurement, construction management, and administrative costs (10% of Direct costs)				$68,460
Health and Safety (2.5% of direct costs)				$17,115
Project management (5% of direct costs)				$34,230
TOTAL INDIRECT CAPITAL COSTS				$127,800
TOTAL CAPITAL COST (DIRECT AND INDIRECT)				$812,395
General Contingency (20% of Direct and Indirect Capital Costs)				$162,479
TOTAL COST OF ALTERNATIVE				$975,000

Key:
CY = cubic yard

Assumptions
10 x 10 foot surface area used to determine soil volumes for single point exceedances. Actual volumes will be defined through field sampling.
* All excavations that extend 6 inches bgs or less will not be backfilled
1.5 tons per cubic yard of soil
2 tons per cubic yard of concrete
Soils targeted for off-site disposal transported to ECDC via rail, cost not included
25% added to imported fill needs to accout for fluff and compaction factors

Table 5-5 *Alternative 5 Cost Estimate*
Off-Site Disposal and Enclose Soils Beneath Roads
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Description	QUANTITY Number	Unit	COST Unit Cost	Total Cost
DIRECT CAPITAL COST				
Excavation, Soil Mound Creation, Off-site Disposal				
Surveying	2	day	$1,200	$2,400
Locate and Mark Burried Utilities	1	lump sum	$700	$700
Breakup, remove and dispose concrete	2,010	CY	$40	$80,400
Excavate and load TPH soils, soils above industrial goals, and other soils targeted for off site dispo	3,900	CY	$15	$58,500
Dispose TPH soil and soils above industrial goals at ECDC	5,850	ton	$20	$117,000
Excavate soil burial area(s), stock pile and sample soils, use as backfill when appropriate	1,700	CY	$23	$39,100
Excavate soils targeted for burial, stockpile and sample, place and compact	1,700	CY	$23	$39,100
Import clean backfill, place, and compact*	2,563	CY	$17	$43,563
Place asphalt cap over soil burial area	17,600	SF	$5	$88,000
Soil sample analysis (stockpiles, leachate testing, and confirmation samples)	130	sample	$200	$26,000
Compaction testing	5	day	$1,000	$5,000
Final surveying and documentation	1	lump sum	$5,000	$5,000
SUBTOTAL				$504,800
Tasks Common to All Action Alternatives				
Abandon monitoring wells, piezometers, free-product probes and collection culverts	1	lump sum	$8,000	$8,000
Drain, clear and grub Ponds A & B, lay rock and fabric prior to backfilling	1	lump sum	$12,000	$12,000
Drain and remove oil/water separator, remove tank saddles	1	lump sum	$9,000	$9,000
Excavate and stockpile Bunker C soils	400	CY	$15	$6,000
Remove ballast and oily soil next to former drip pad	130	CY	$15	$1,950
Soil sampling and analysis (profiling and confirmation)	15	sample	$200	$3,000
Fill and compact Ponds A&B, Bunker C area, and former drip slab*	3,000	CY	$17	$51,000
Dispose Bunker C soils and oily soils at ECDC	800	ton	$20	$16,000
SUBTOTAL				$107,000
Labor				
Construction oversight, Technicians, and expenses (15% of Capitol Costs)				$91,770
TOTAL DIRECT CAPITAL COST				$703,570
Administrative and Indirect Capital Costs				
Deed restriction legal costs	1	lump sum	$10,000	$10,000
DEQ Oversight	1	lump sum	$10,000	$10,000
Engineering, procurement, construction management, and administrative costs (10% of Direct costs)				$70,357
Health and Safety (2.5% of direct costs)				$17,589
Project management (5% of direct costs)				$35,179
TOTAL INDIRECT CAPITAL COST				$143,100
Annual Operation and Maintenance (O&M)				
Cap inspection	1	lump sum	$1,500	$1,500
Cap maintenance	1	lump sum	$1,500	$1,500
Periodic ODEQ Review				$500
ANNUAL O&M COSTS				$3,500
30-YEAR NET PRESENT VALUE OFANNUAL O&M COSTS				$100,000
TOTAL CAPITAL COST (DIRECT AND INDIRECT)				$846,670
General Contingency (20% of Direct and Indirect Capital Costs)				$169,334
TOTAL COST OF ALTERNATIVE (PRESENT WORTH)				$1,116,000

Key:
CY = cubic yard
SF = square foot

Assumptions
Deed restriction required to ensure that asphalt over burial area(s) remain intact
Soils exceeding only residential goals will be buried on site
* All excavations that extend 6 inches bgs or less will not be backfilled
1.5 tons per cubic yard of soil
2 tons per cubic yard of concrete
All soils targeted for off-site disposal transported to ECDC via rail, cost not included
25% added to imported fill needs to accout for fluff and compaction factors

Table 6-1 *Residual Risk Calculations*
Union Pacific Railroad Company
Ashland Rail Yard
Ashland, Oregon

Constituent	Residential Cleanup Level (mg/kg)		Maximum Residual Soil Concentration (Not Exceeding Residential Clean-Up Level) (mg/kg)	Carcinogenic Risk	Noncarcinogenic Hazard Index
Total Petroleum Hydrocarbons (TPH)					
TPH (speciation results)	1,558	nc	640		4.1E-01
TPH (diesel)	---		---		
Volatile Organic Compounds					
Benzene	0.27	c	0.07	2.6E-07	
Toluene	--		0.17		
Ethylbenzene	392	nc	3.6		9.2E-03
Xylenes	146,500	nc	1.2		8.2E-06
Polynuclear Aromatic Hydrocarbons					
Acenaphthene	3,116	nc	0.36		1.2E-04
Acenaphthylene	--	nc	0.028		
Anthracene	15,580	nc	0.34		2.2E-05
Benzo(a)anthracene	0.64	c	0.24	3.8E-07	
Benzo(a)pyrene	0.06	c	0.056	9.3E-07	
Benzo(b)fluoranthene	0.64	c	0.21	3.3E-07	
Benzo(g,h,i)perylene	--	nc	0.27		
Benzo(k)fluoranthene	6.37	c	0.071	1.1E-08	
Chrysene	63.7	c	0.23	3.6E-09	
Dibenzo(a,h)anthracene	0.06	c	0.05	8.3E-07	
Fluoranthene	2,077	nc	0.16		7.7E-05
Fluorene	2,077	nc	0.33		1.6E-04
Indeno(1,2,3-cd)pyrene	0.64	c	0.24	3.8E-07	
Naphthalene	2,077	nc	0.17		8.2E-05
Phenanthrene	--	nc	0.51		
Pyrene	1,558	nc	0.65		4.2E-04
Metals					
Arsenic	30	b	28		
Barium	2,161	nc	230		1.1E-01
Cadmium	834//34.5	c//nc	3.7	4.4E-09	1.1E-01
Chromium	15,140	nc	39		2.6E-03
Iron	--		33,900		
Lead	200	Pb	190		
Mercury	16.2	nc	3.3		2.0E-01
Phosphorus	--		970		
Potassium	--		4,900		
Selenium	366	nc	0.44		1.2E-03
Silver	284	nc	0.48		1.7E-03
Sulfur	--		ND		
			Total	3E-06	0.8

Notes:
1. -- No cleanup goal was calculated (ERM, Final Remedial Investigation Report/Ashland Yard, November 1999).
2. c - cleanup level based on carcinogenic effects; nc - cleanup level based on noncarcinogenic effects.
3. b - cleanup level based on background levels; constituent not considered in cumulative risk calculations (see text).
4. Pb - cleanup level based on estimated blood lead (Pb) level; lead was not considered in the cumulative risk calculations (see text).
5. Estimated carcinogenic risk = 0.000001 x maximum residual concentration/residential cleanup level.
6. Estimated noncarcinogenic hazard index = maximum residual concentration/residential cleanup level.
7. Both carcinogenic and noncarcinogenic residential cleanup levels were developed for cadmium, and so both were considered in this analysis.
8. The total estimated carcinogenic risk and noncarcinogenic hazard index are acceptable under ODEQ guidelines (see text).
9. 1E-06 = 0.000001; ND - not detected

Appendix A Remedial Investigation Report Figures

List of Figures:

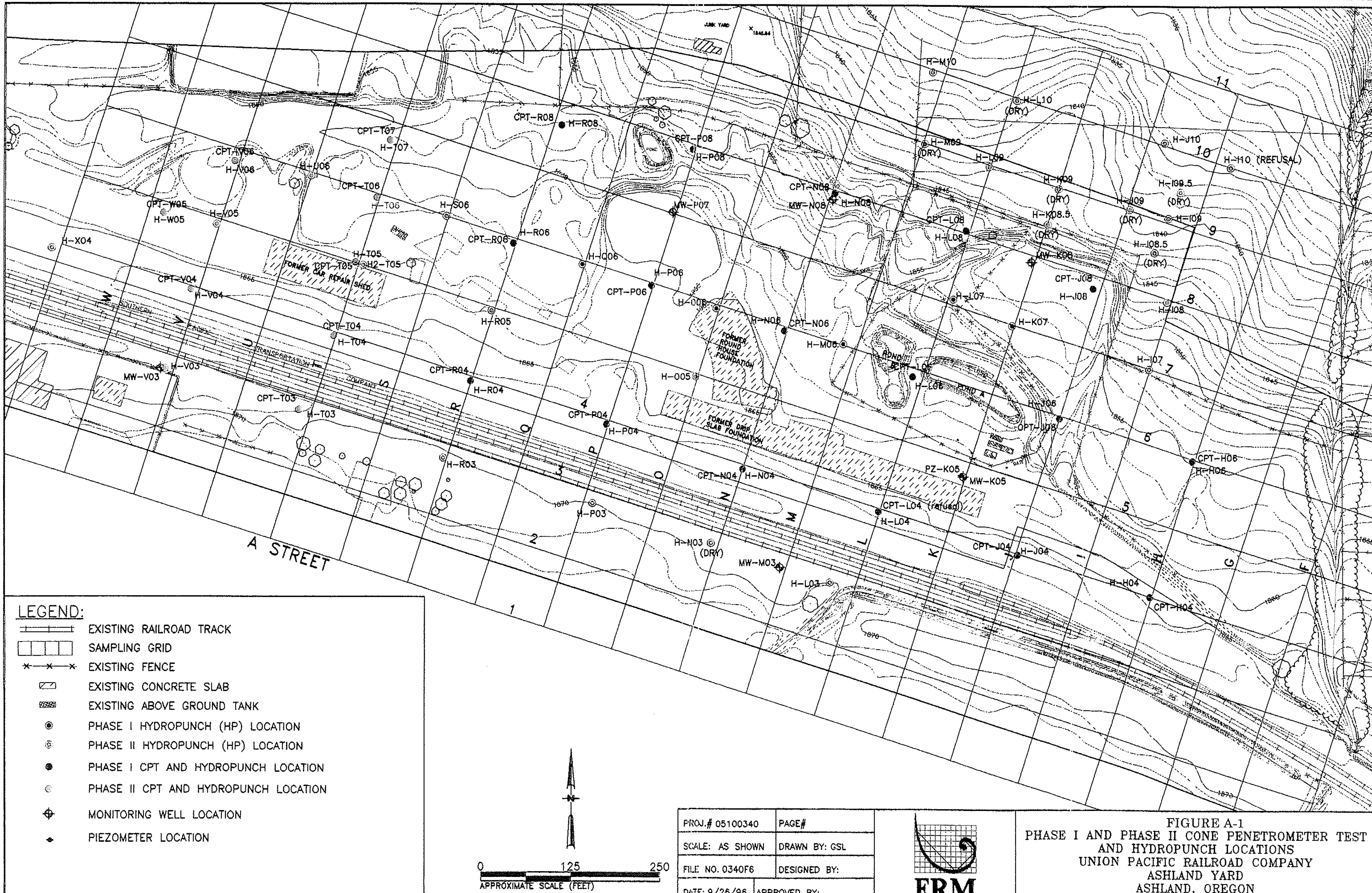

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FIGURE A-1
PHASE I AND PHASE II CONE PENETROMETER TEST AND HYDROPUNCH LOCATIONS
UNION PACIFIC RAILROAD COMPANY
ASHLAND YARD
ASHLAND, OREGON

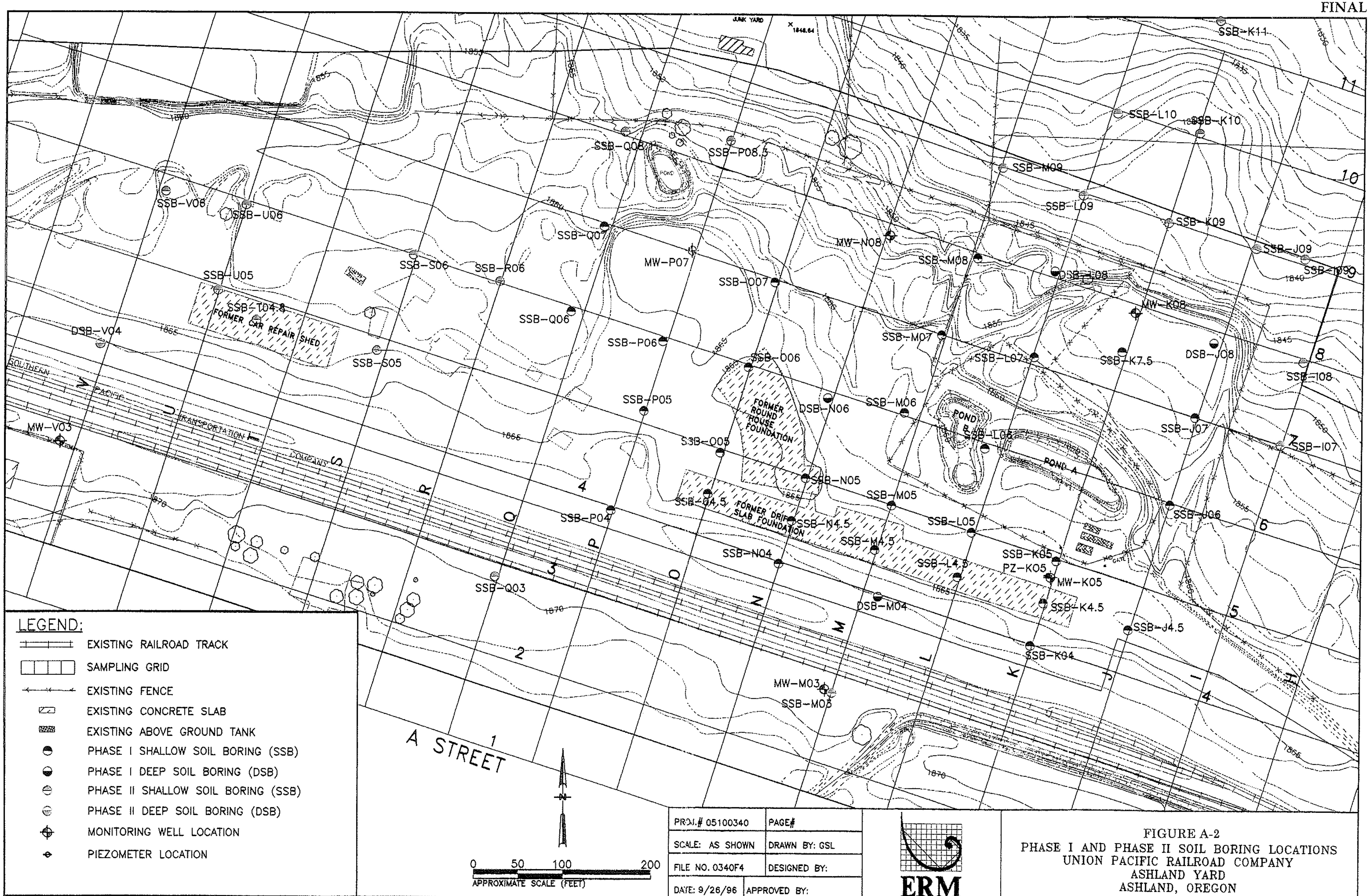
JUNK YARD
SOUTHERN PACIFIC TRANSPORTATION COMPANY
FORMER CAR REPAIR SHED
FORMER ROUND HOUSE FOUNDATION
FORMER DRIP SLAB FOUNDATION
POND A
POND B
A STREET
SSB-K11
SSB-L10
SSB-K10
SSB-Q08
SSB-P08.5
SSB-M09
SSB-L09
SSB-K09
SSB-V06
SSB-U06
SSB-Q07
MW-N08
SSB-J09
MW-P07
SSB-M08
SSB-S06
SSB-R06
SSB-O07
DSB-L08
SSB-I09
SSB-U05
MW-K08
SSB-T04.8
SSB-Q06
DSB-V04
SSB-M07
SSB-P06
SSB-K7.5
DSB-J08
SSB-S05
SSB-O06
SSB-L07
SSB-I08
DSB-N06
SSB-M06
SSB-P05
SSB-J07
MW-V03
SSB-L06
SSB-O05
SSB-I07
SSB-N05
SSB-M05
SSB-O4.5
SSB-P04
SSB-N4.5
SSB-L05
SSB-J06
SSB-M4.5
SSB-N04
SSB-K05
SSB-L4.5
PZ-K05
MW-K05
SSB-Q03
DSB-M04
SSB-K4.5
SSB-J4.5
SSB-K04
MW-M03
SSB-M03
LEGEND:
EXISTING RAILROAD TRACK
SAMPLING GRID
EXISTING FENCE
EXISTING CONCRETE SLAB
EXISTING ABOVE GROUND TANK
PHASE I SHALLOW SOIL BORING (SSB)
PHASE I DEEP SOIL BORING (DSB)
PHASE II SHALLOW SOIL BORING (SSB)
PHASE II DEEP SOIL BORING (DSB)
MONITORING WELL LOCATION
PIEZOMETER LOCATION
0 50 100 200
APPROXIMATE SCALE (FEET)
N
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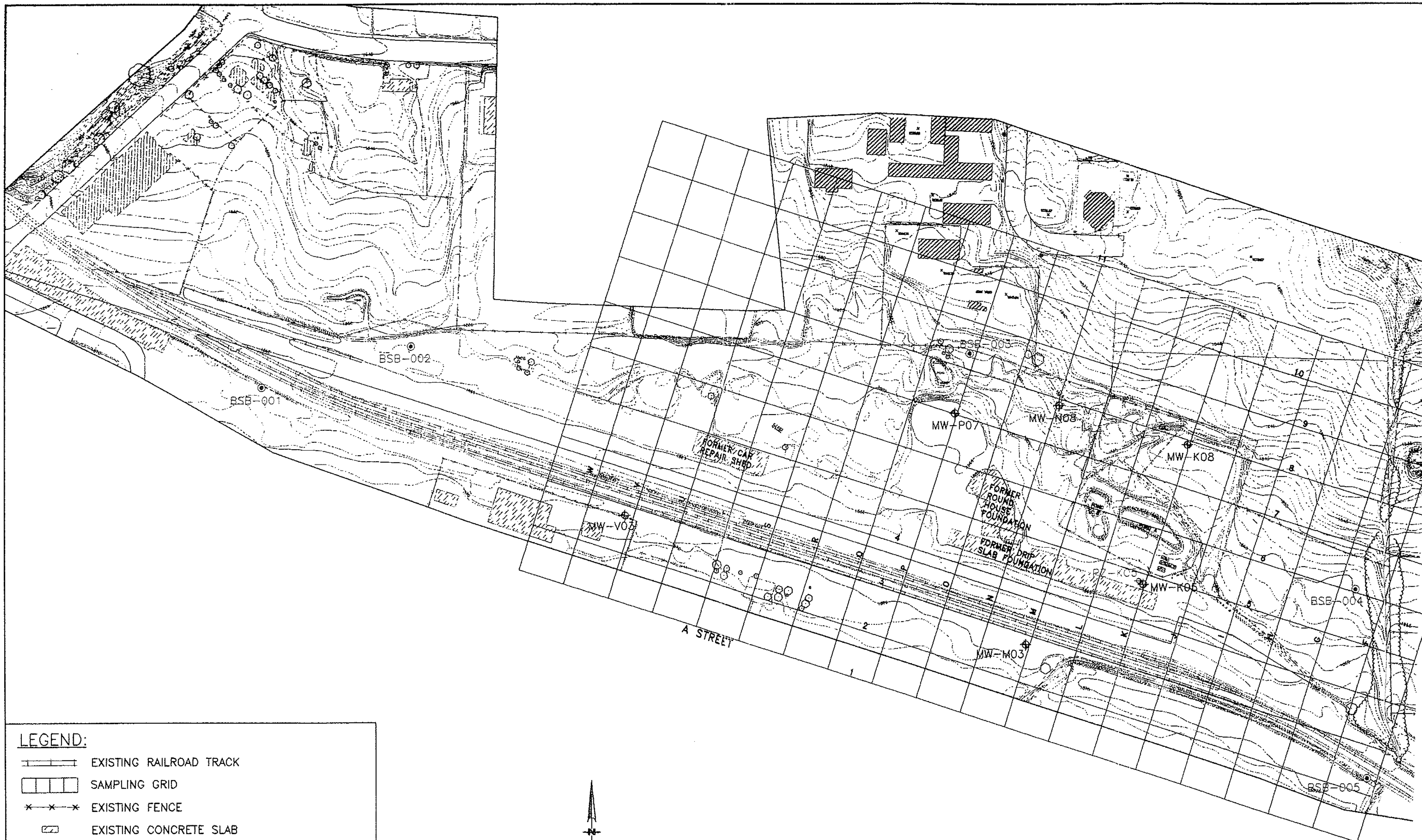
FIGURE A-2
PHASE I AND PHASE II SOIL BORING LOCATIONS
UNION PACIFIC RAILROAD COMPANY
ASHLAND YARD
ASHLAND, OREGON



LEGEND:

- EXISTING RAILROAD TRACK
- SAMPLING GRID
- EXISTING FENCE
- EXISTING CONCRETE SLAB
- EXISTING ABOVE GROUND TANK
- BACKGROUND SOIL BORING
- MONITORING WELL LOCATION
- PIEZOMETER LOCATION

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FIGURE A-3
BACKGROUND SOIL BORING, MONITORING WELL AND PIEZOMETER LOCATIONS
UNION PACIFIC RAILROAD COMPANY
ASHLAND YARD
ASHLAND, OREGON

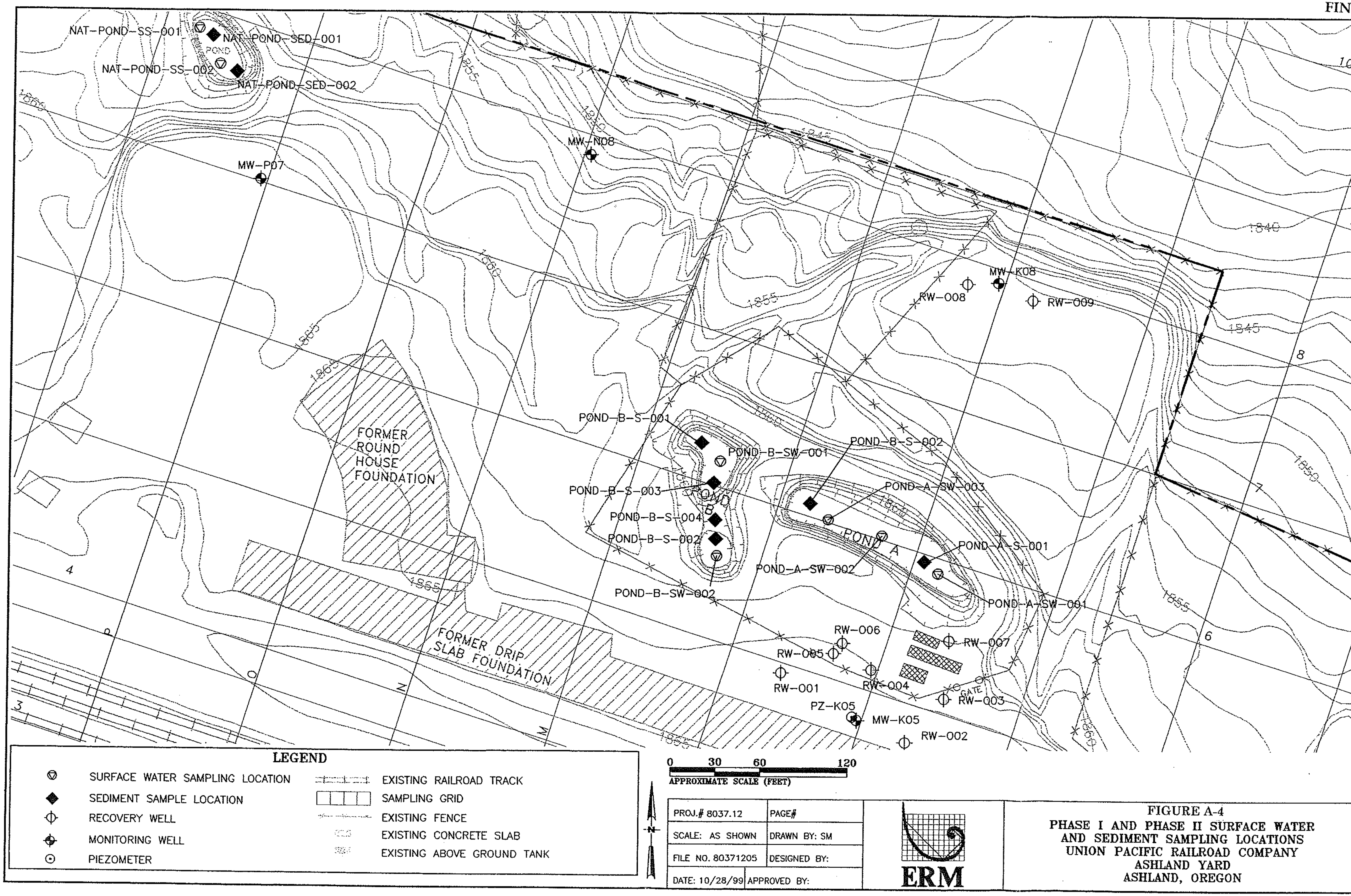

FIGURE A-4
PHASE I AND PHASE II SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
UNION PACIFIC RAILROAD COMPANY
ASHLAND YARD
ASHLAND, OREGON

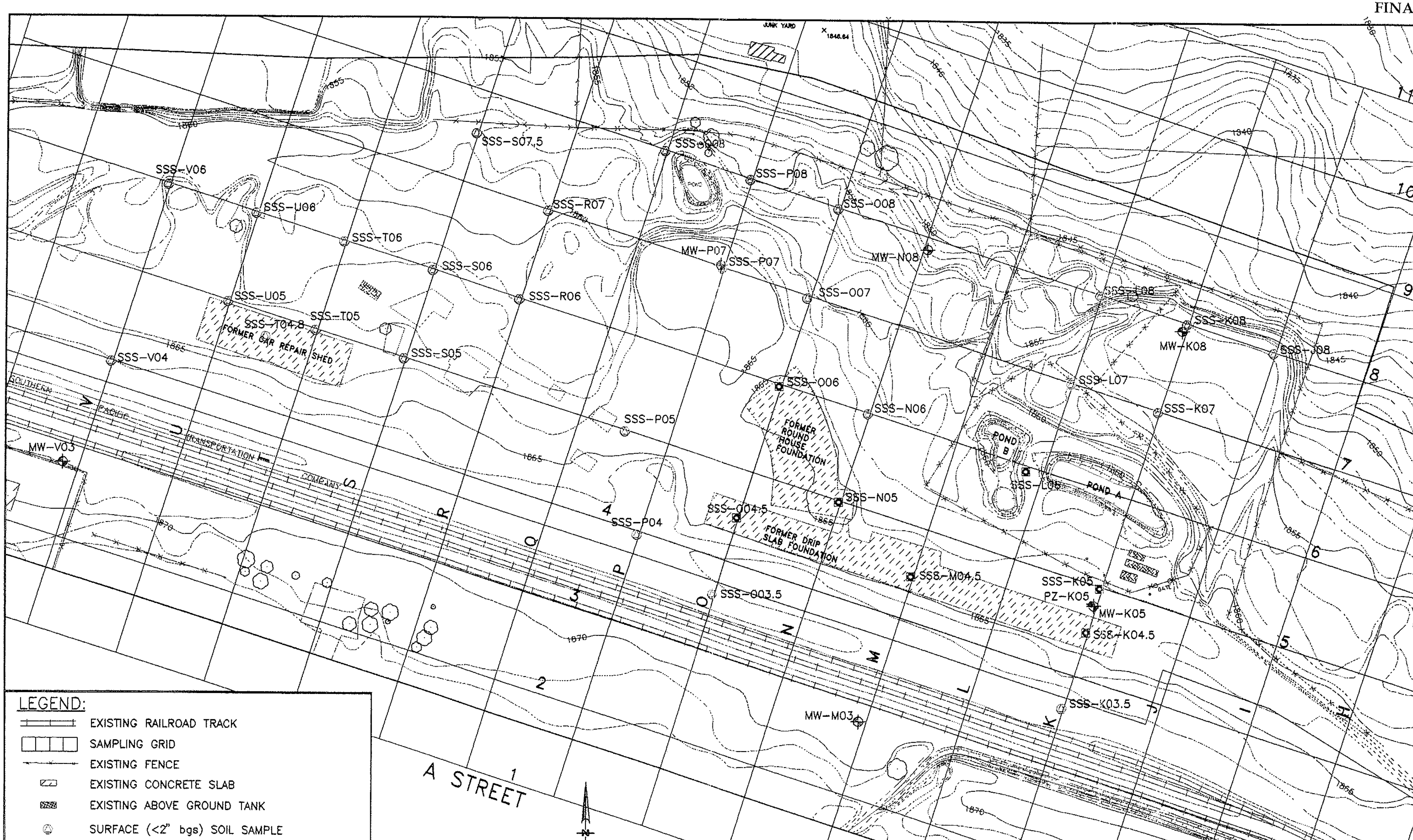

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FIGURE A-5
PHASE II SURFACE AND SHALLOW SUBSURFACE SOIL SAMPLING LOCATIONS
UNION PACIFIC RAILROAD COMPANY
ASHLAND YARD
ASHLAND, OREGON

FINAL

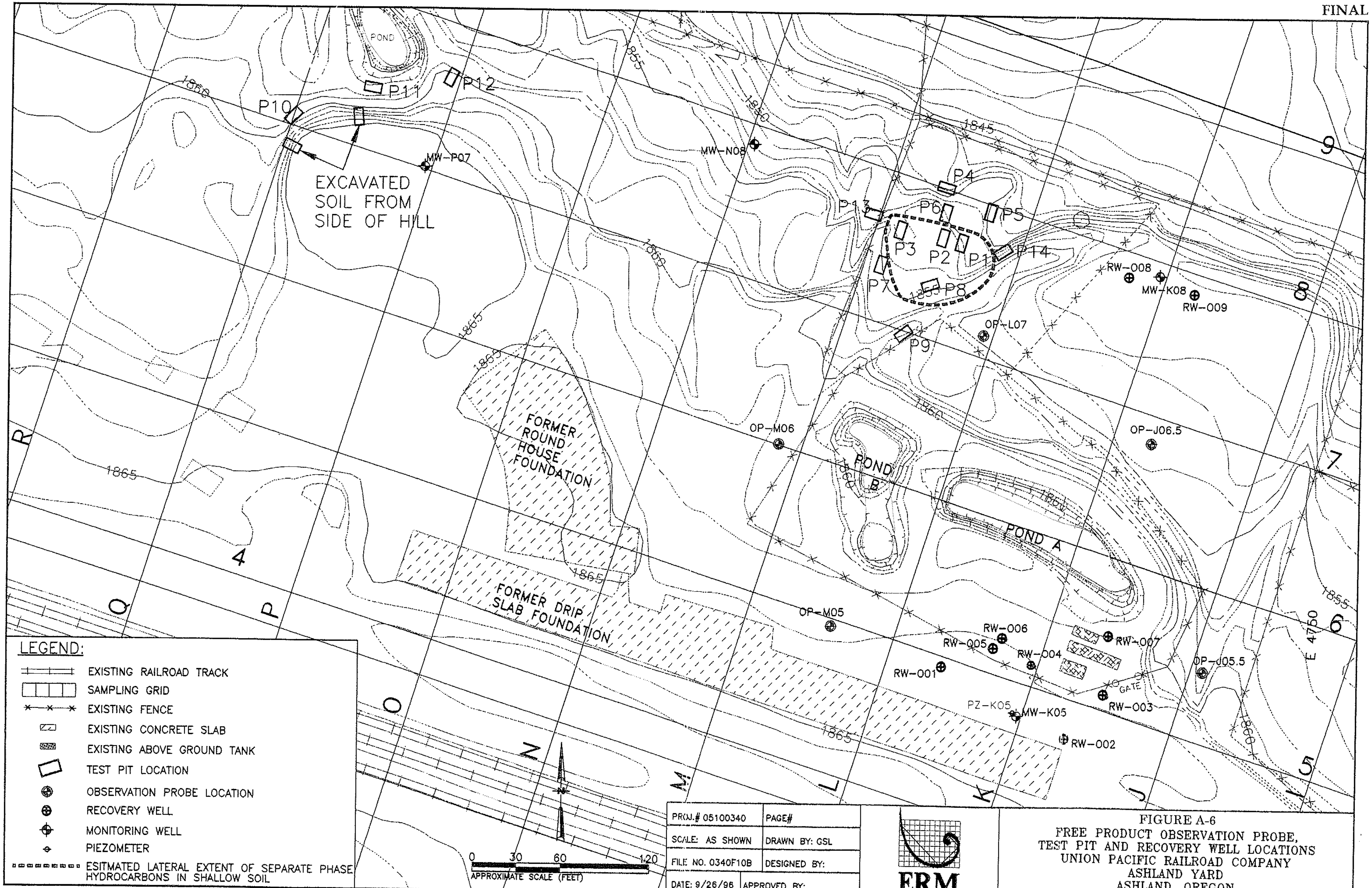

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FIGURE A-6
FREE PRODUCT OBSERVATION PROBE, TEST PIT AND RECOVERY WELL LOCATIONS
UNION PACIFIC RAILROAD COMPANY
ASHLAND YARD
ASHLAND, OREGON