

Georgia-Pacific LLC

**Remedial Investigation Report
Operable Unit A
Coastal Trail and Parkland Zone**

Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

October 2007
Revised February 2008

Bridgette DeShields

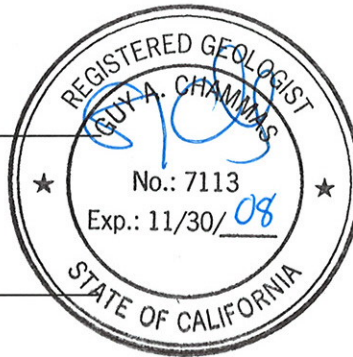
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Zone**

Former Georgia-Pacific Wood
Products Facility
Fort Bragg, California

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Georgia-Pacific LLC

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Acronyms and Abbreviations

ADD	average daily dose
AE	assessment endpoint
ALM	Adult Lead Methodology
AME	Acton•Mickelson•Environmental, Inc.
amsl	above mean sea level
AOI	Area of Interest
BAF	bioaccumulation factor
B(a)P	benzo(a)pyrene
BEHP	bis(2-ethylhexyl)phthalate
BERA	baseline ecological risk assessments)
bgs	below ground surface
BHHRA	baseline human health risk assessment
BTAG	Biological Technical Assistance Group
BTEX	benzene, toluene, ethylbenzene, total xylenes

CalEPA	California Environmental Protection Agency
CCR	Current Conditions Report
CDP	Coastal Development Permit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHHSL	California Human Health Screening Level
City	City of Fort Bragg
cm	centimeter(s)
cm ²	square centimeter(s)
CNDDDB	California Natural Diversity Database
CNPS	California Native Plant Society
COI	chemical of interest
Complex	Franciscan Complex
COPC	constituent of potential concern
Cr III	trivalent chromium
Cr VI	hexavalent chromium
CSC	Species of Special Concern – California Department of Fish and Game
CSF	cancer slope factor
CSM	conceptual site model
CTE	central tendency estimate or exposure
DQO	data quality objective
DTSC	Department of Toxic Substances Control
EcoSSL	Ecological Soil Screening Levels
EFH	Exposure Factors Handbook
ELCR	excess lifetime cancer risk
EM31	ground conductivity survey
EM61	metal detector survey

EPC	exposure point concentration
ERA	ecological risk assessment
ESA	environmental site assessment
EU	exposure unit
°F	degrees Fahrenheit
FOD	frequency of detection
GANDA	Garcia and Associates
Georgia-Pacific	Georgia-Pacific LLC
GSDi	geometric standard deviation
HEAST	Health Effects Assessment Summary Tables
het	heterogeneity
HI	hazard index
HMW	high molecular weight
hom	homogeneity
HQ	hazard quotient
IRIS	Integrated Risk Information System
kg	kilogram(s)
L	liter(s)
LADD	lifetime average daily dose
LMW	low molecular weight
LOAEL	low adverse effect level
m ³	cubic meter(s)
ME	measurement endpoint
MCL	Maximum Contaminant Level
mg/cm ² -day	milligrams per square centimeter per day
mgd	million gallons per day
mg/day	milligrams per day
mg/kg	milligram(s) per kilogram

mg/kg-day	milligrams per kilogram per day
mg/L	milligram(s) per liter
NOAEL	no adverse effect level
Ocean Plan	Ocean Plan Water Quality Objectives
OEHHA	Office of Environmental Health Hazard Assessment
OP-HH	Ocean Plan Human Health Criteria
(the) Order	Site Investigation and Remediation Order for the site (Docket No. HSA-RAO 06-07-150)
ORNL	Oak Ridge National Laboratory
OU	operable unit
OU-A	Operable Unit A, the Coastal Trail and Parkland Zone
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pg/g	picogram(s) per gram
PEF	particulate emission factor
PHG	public health goal
PID	photoionization detector
PPRTV	Provisional Peer Reviewed Toxicity Value
PRA	presumptive remediation area
PRG	Preliminary Remediation Goal
RAGS	Risk Assessment Guidance for Superfund
RBSC	risk-based screening concentration
REL	Reference Exposure Level
RfC	reference concentration
RfD	chronic reference dose
RI	remedial investigation
RME	reasonable maximum estimate or exposure
RQ	risk question
RWQCB	Regional Water Quality Control Board

site	the former Georgia-Pacific Wood Products Facility
SLERA	screening-level ecological risk assessment
SUF	site use factor
SVOC	semivolatile organic compound
TCDD	tetrachlorodibenzo- <i>p</i> -dioxin
TSCA	Toxic Substances Control Act
TEF	toxicity equivalency factor
TEQ	toxic equivalent
TIC	tentatively identified compound
TPH	total petroleum hydrocarbons
TPHd	total petroleum hydrocarbons as diesel
TPHg	total petroleum hydrocarbons as gasoline
TPHmo	total petroleum hydrocarbons as motor oil
TRC	TRC Companies, Inc.
TRV	toxicity reference value
µg/dl	microgram(s) per deciliter
µg/L	microgram(s) per liter
UCL	upper confidence limit
ULC	Union Lumber Company
USEPA	U.S. Environmental Protection Agency
VF	volatilization factor
VOC	volatile organic compound
WRA	Wetlands Research Associates

Executive Summary

This Remedial Investigation Report (RI Report) for Operable Unit A, the Coastal Trail and Parkland Zone (OU-A), was prepared by ARCADIS BBL on behalf of Georgia-Pacific, LLC (Georgia-Pacific) for the former Georgia-Pacific Wood Products Facility (site) located at 90 West Redwood Avenue, Fort Bragg, Mendocino County, California (Figure 1-1). This RI Report, which includes human health and ecological risk assessments, is a component required by the Department of Toxic Substances Control (DTSC) under Sections 5.4 and 5.6 of the Site Investigation and Remediation Order for the site (Docket No. HSA-RAO 06-07-150; the Order). According to the Order, “the purpose of the RI is to collect data necessary to adequately characterize the Site for the purposes of defining risks to public health and the environment and developing and evaluating effective remedial alternatives for foreseeable land uses” and “identify the sources of contamination and define the nature, extent, and volume of the contamination.”

This RI Report provides sufficient characterization of the nature and extent of chemical contamination within OU-A. Five areas were identified through review of the data as appropriate for remedial action based on factors that included the presence of hazardous waste, polychlorinated biphenyls (PCBs) above the a regulatory threshold, or areas considered “hot spots” where concentrations of chemicals were over 10 times protective health-based screening levels. The five areas will be targeted for remediation and carried forward into the remedial planning process. Based on an assessment of the residual risks to human health and the environment following assumed remediation of the five targeted areas, risks are predicted to be within the acceptable range. The objectives of the RI were met and no further evaluation is warranted.

Background

The approximately 415-acre site is located west of Highway 1 along the Pacific Ocean coastline and is bounded by open coastline to the north, Noyo Bay to the south, the City of Fort Bragg (City) to the east, and the Pacific Ocean to the west. According to historical records, Union Lumber Company (ULC) began sawmill operations at the site in 1885. Georgia-Pacific acquired the site in 1973 and ceased lumber operations on August 8, 2002. OU-A is defined in the Order as an approximately 100- to 110-foot-wide pathway that traverses the top of the coastal bluff. In addition, OU-A includes an approximately 30-acre parkland area (Figure 1-2). The western boundary

of OU-A is the mean high tide line. The total acreage of OU-A is approximately 87 acres (Figure 1-2).

This RI Report summarizes historical information as it pertains specifically to OU-A and recently collected data. OU-A includes portions of the following six parcels; Parcel 1: North Coast, Parcel 3: Industrial, Parcel 6: Planer, Parcel 7: Sawmill #2, Parcel 8: Log Storage, and Parcel 10: South Coast. OU-A includes two geographically separate units that will be referred to as OU-A North (22 acres) and OU-A South (65 acres). OU-A North includes the western portion of Parcel 1 and the southwestern corner of Parcel 3. OU-A South includes small portions of Parcels 6 and 7, where the future trail corridor borders the City Wastewater Treatment Plant; a portion of Parcel 8; and most of Parcel 10. OU-A North is largely paved and disturbed. In contrast, OU-A South is largely unpaved.

For purposes of discussion, each of the geographic units within OU-A (OU-A North and OU-A South) was further subdivided into smaller areas of interest (AOIs) based on historical usage, previous investigations, and sampling recommended in the *Site Investigation Work Plan* (ARCADIS BBL, 2007i). These 16 AOIs are shown on Figures 2-3 and 2-4.

Geologic and Hydrogeologic Setting

Fort Bragg is located along the northern California coastline within the Coast Range geomorphic province. Geologic units present in Fort Bragg and the vicinity include surface geologic units, including deposits of beach and dune sands, alluvium, and marine terrace deposits. The site is underlain by Quaternary (less than 1.5 million years old) terrace sediments deposited on wave-cut surfaces parallel to the coast. The terrace deposits consist of poorly to moderately consolidated marine silts, sands, and gravels and are overlain by a 3- to 4-foot-thick mantle of topsoil.

Groundwater at the site is encountered at approximately 11.5 feet below ground surface (bgs) in OU-A North and from 7 to 27 feet bgs in OU-A South. Generally, monitoring data and topographic gradients demonstrate that onsite groundwater flow is primarily to the west-southwest toward the Pacific Ocean.

Habitats and Cultural Resources

Various habitat types, plant communities, and animal species occur or likely occur within OU-A. OU-A consists primarily of upland habitat, most of which can be classified

as highly disturbed habitat. The majority of the upland habitat is covered in non-native grasses, asphalt, and/or industrial development. Other habitat types present in OU-A include northern coastal bluff scrub and a small area of coastal terrace prairie. The plant community in OU-A is composed primarily of grasses and scrub brush. There are isolated areas of wetland plants in the very southern portion of OU-A in the small riparian wetland seep area. The only trees within OU-A are those around the Native American homes in OU-A South.

Archival research and cultural resource surveys have been conducted for the entire site and found that portions of the property are considered likely to contain intact prehistoric deposits and the property contains three historic sites and areas that are likely to contain historic deposits that are important in understanding the early settlement and development of the local community as well as the lumber operations on the property.

Conceptual Site Model

The primary sources of chemicals of interest (COIs) in site media at OU-A consist of material storage, equipment usage, and facilities operations or practices that contained and/or had the potential to release hazardous substances. As the site was used primarily as a redwood sawmill, the use of wood treatment chemicals was limited to two areas for a short period of time; neither area was near or adjacent to the boundary of OU-A. The only other treated wood located onsite is associated with railroad ties, possibly impregnated with chromated copper arsenate or creosote (finished products only, not manufactured onsite) that make up a rail line and spur that extended into the southern portion of Parcel 10 in OU-A. These rail lines have since been removed.

OU-A North, which consists mainly of a thin strip of land that constitutes the western border of the mill site, was not used for any specific industrial activities during operation of the mill, but was historically used for log storage. The northern portion of OU-A North (Parcel 1), including Glass Beaches 1 and 2, was not part of the mill until 1947 and was used as a public and private dump. Formal ownership of Glass Beaches 1 and 2 prior to 1947 is currently being reviewed. Disposal included household waste, scrap metal, and automobiles. Debris materials were discharged both directly onto the bluff top and face near the ocean and also placed into shallow pits for burning. Prior to 1960, an explosives storage shed near the southern end of Glass Beach 2 was used to store dynamite, blasting caps, fuses, and possibly nitroglycerin. These materials were not actually used onsite, but rather were exclusively employed to break up log jams at offsite locations. A scrap yard at the southern end of OU-A North was used for a few

years (starting in 1995) for laydown of mostly metal scrap (this scrap was removed in 2004). As discussed in Section 2, there is little evidence of buried debris in OU-A North.

OU-A South was not historically used for industrial sawmill operations (other than some log storage). Potential sources associated with OU-A South include the former Clinker and Ash/Scrap Piles, a Fill Area that encompasses most of OU-A South (where ash and other debris were historically placed), an airstrip, and an area of disposal at the Blowhole feature to the south.

On the basis of the discussion above, the COIs in site media potentially associated with the sources described above are metals, polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH), and dioxins/furans (ash/burn debris only). Because of anecdotal accounts reporting the disposal of transformers, PCBs are included as COIs for OU-A North. Site media was also analyzed for additional parameters, such as volatile organic compounds (VOCs), based on DTSC input and for completeness.

Site Investigation and Nature and Extent

The purpose of the site investigation work conducted between April and August 2007 was to collect additional data needed to prepare this RI Report, which includes risk assessments and assessment of the nature and extent of contamination. Review of existing data (which included 155 soil samples, 3 groundwater grab samples, and samples from 4 wells and 6 springs that are regularly monitored) identified some areas of OU-A where there were data gaps. In some areas, there was a lack of sampling in a particular location or depth. For example, in the areas between the Glass Beaches in OU-A North, there were some areas where samples had not been collected or where data for surface soil (0 to 0.5 foot bgs) were lacking. Other data gaps consisted of areas where additional chemical analyses were needed in areas that had been previously tested. For example, further characterization of fill areas in OU-A South for dioxins/furans was needed, although data were available for other chemicals in this area.

Between April 16 and August 17, 2007, ARCADIS BBL collected the following samples in OU-A:

- 47 soil samples from 89 test pits

- 101 soil samples from 39 direct push (Geoprobe™) borings
- 175 soil samples from 80 hand auger borings
- 20 terrestrial invertebrate and 20 co-located plant samples.

Samples were analyzed for one or more of the following: Title 22 metals, TPH (gasoline [TPHg], diesel [TPHd], and motor oil [TPHmo]), PAHs, VOCs, PCB congeners, and dioxins/furans.

Sample results were screened against various levels for the analytes described above. For the inorganic chemicals, soil samples were compared to site background concentrations. The site-specific lead background level for fill lithology soils is currently under discussion. The final agreed-upon value is expected to be at or above 25 mg/kg. Therefore, for this RI, a value of 25 mg/kg has been used as an interim background level. In cases where background levels are higher than the screening level (California Human Health Screening Level [CHHSL; CalEPA, 2005a] or Preliminary Remediation Goal [PRG; USEPA, 2004a), results were evaluated against their respective background concentrations (e.g., arsenic and cadmium). The soil samples that were analyzed for the remaining analytical suites were first screened against CHHSLs (CalEPA, 2005a). If no CHHSL was available, data were screened against the U.S. Environmental Protection Agency (USEPA) Region IX PRGs for residential use (USEPA, 2004a). No CHHSLs or PRGs are available for TPH. Therefore, TPH data in soil were screened against site-specific, risk-based screening concentrations (RBSCs).

Identification of Presumptive Remedy Areas

A preliminary evaluation of the data collected from OU-A determined that “presumptive remedies” are warranted in select areas of OU-A. A presumptive remedy area (PRA) is defined as an area that likely poses an unacceptable risk or exhibits other criteria that would require remedial action regardless of the results of any risk evaluations. Five PRAs were identified for OU-A through an initial data evaluation and any one of the following criteria:

- Presence of metals above the California Hazardous Waste threshold (California Code of Regulations Title 22 Social Security, Division Health Standards for the Management of Hazardous Waste, Chapter 11)

- Presence of PCBs above the action level for PCBs (under the performance-based approach) from the Toxic Substances Control Act (TSCA) (40 Code of Federal Regulations 761.3)
- Presence of “significant” hot spots – areas where two or more adjacent sample locations had concentrations that were 10 times or more the residential CHHSL.

The establishment of PRAs for soils that meet the above criteria indicates that these areas will be addressed through remediation (both lateral and vertical extent).

OU-A North

In OU-A North, the following AOIs were investigated:

- Glass Beach 1
- Between Glass Beaches 1 and 2
- Glass Beach 2
- Between Glass Beaches 2 and 3,
- Glass Beach 3
- East of Glass Beach 3
- Parcel 3 Geophysical Anomaly/Former Scrap Yard Area.

In general, the Glass Beach Areas soil showed the following COIs above their respective screening levels: arsenic and cadmium (both just slightly above background), lead, benzo(a)pyrene [B(a)P] toxic equivalents (TEQs), and tetrachlorodibenzo-*p*-dioxin (TCDD) TEQs. However, sampling results have typically defined the horizontal and vertical extent of the impacts and were determined to be sufficient for risk assessment purposes. Exceedances were typically minor (less than 10 times background or screening levels) or limited in spatial extent, with the exception of Glass Beach 2 where a small portion had elevated concentrations of lead (meeting California Hazardous Waste criteria). Therefore, a portion of this AOI has been identified as a PRA. Soil in this area will be remediated to a depth of approximately 2 feet. Soil outside the PRA did not contain lead above screening levels.

In Parcel 3, the soil showed the following COIs above their respective screening levels: arsenic, cadmium, and vanadium (all just slightly above background); PAHs; TPH; and PCBs. However, PCBs were the only analyte that exceeded their screening levels by 10 times, and total PCBs also exceeded the TSCA performance-based criterion of 1 milligram per kilogram (mg/kg). The elevated PAHs and TPH are also within this same area. Therefore, this area has been identified as a PRA. Soil in this area will be remediated to a depth of approximately 6 to 12 inches bgs. PCB soil concentrations below 0.5 to 1 foot bgs and outside the PRA did not exceed screening levels.

OU-A South

In OU-A South, the following AOIs were investigated:

- Parcels 6 and 8 Coastline
- North of the Parcel 8 Clinker Area
- Parcel 8 Clinker/Fill Area
- Parcel 10 Geophysical Anomaly/Clinker Area
- Parcel 10 Fill Area
- Former Railroad Tracks
- Blowhole
- Parcel 8 Fill Area
- North of Native American Homes.

The results from soil samples collected at AOIs Parcel 6 and 8 Coastline, North of the Parcel 8 Clinker Area, Parcel 8 Clinker/Fill Area, Blowhole, Parcel 8 Fill Area, and North of Native American Homes showed that the chemicals investigated did not exceed background and/or screening levels. The AOIs that had concentrations of COIs above background and/or screening levels were the Parcel 10 Geophysical Anomaly/Clinker Area, Parcel 10 Fill Area, and Former Railroad Tracks. The following is a summary of the findings in these parcels:

- Parcel 10 Geophysical Anomaly/Clinker Area. The analytical results for soils showed the following COIs above their respective screening levels: arsenic, lead, and vanadium (just above background levels in most locations); and B(a)P and TCDD TEQs. Other chemicals were either not detected or detected below background and/or screening levels. Although arsenic, lead, vanadium, B(a)P TEQ, and TCDD TEQ were detected above screening levels, the exceedances were relatively minor (less than 10 times background or screening levels) or limited in spatial extent, and the extent is characterized and defined sufficiently for risk assessment purposes.
- Parcel 10 Fill Area. The analytical results for soils showed the following COIs above their respective screening levels: arsenic (just above background levels), B(a)P TEQs, and TCDD TEQs over their respective background and/or screening levels. Other chemicals were either not detected or detected below background and/or screening levels. Although arsenic and B(a)P TEQs were detected above screening levels, the exceedances are minor, and the extent is defined sufficiently for risk assessment purposes. The elevated TCDD TEQ concentrations were found mainly within three areas in the Parcel 10 fill area. Concentrations at nine locations were more than 10 times the screening level (CHHSL: 4.6 picograms per gram [pg/g]). Three small areas were identified as PRAs based on the criteria described above: one in the northern portion of the AOI and two in the southern portion of the AOI. Soils in these areas are presumed to be addressed by excavation to a depth ranging from 2 to 5 feet bgs. TCDD TEQ soil concentrations outside the PRAs either did not exceed or only slightly exceeded the screening level and are further assessed in the risk assessment.
- Former Railroad Tracks. The analytical results from Former Railroad Tracks showed exceedances of B(a)P TEQs over the screening level. Other chemicals were either not detected or detected below background and/or screening levels. Although B(a)P as TEQs was detected above screening levels, the exceedance is low in magnitude and appears to be very limited in extent.

Groundwater and Surface Water

Based on the limited historical activities and limited detections of COIs in soil samples from OU-A, monitoring wells present in OU-A are located in Parcel 10 in OU-A South. These include monitoring wells MW-10.1 through MW-10.4. Historically, dissolved arsenic, dissolved beryllium, benzene, and bis(2-ethylhexyl)phthalate (BEHP) have been the only four COIs detected in Parcel 10 groundwater at concentrations in excess

of their respective applicable screening levels. Other chemicals were either not detected or detected below background and/or screening levels. The exceedances of screening levels discussed above are minor, are not considered to be of significant concern, and unlikely to result in unacceptable risks.

There are six groundwater seep locations in OU-A. Four (SP-1.1 through SP-1.4) are located in Parcel 1, one (SP-10.1) is located in Parcel 10, and one (SP-8.1) is located in Parcel 8. These seeps were sampled in 2006 and 2007. The samples from the seeps showed exceedances of beryllium, naphthalene, and TPHmo above their respective screening levels. Other chemicals were either not detected or detected below background and/or screening levels. Exceedances of screening levels for these springs are minor and considered insignificant given the high level of dilution (for example, wastewater discharges are commonly given a 50-fold dilution factor in this area).

Summary and Key Nature and Extent Findings

As discussed previously, the shallow soil in OU-A is primarily impacted with select metals, B(a)P TEQs, TPHd and TPHmo, PCBs, and dioxins/furans above screening levels. Two areas in OU-A North (Glass Beach 2 and the Parcel 3 Former Scrap Yard) and three areas within OU-A South (all within the Parcel 10 Fill Area) have been targeted as PRAs because of elevated concentrations of lead, PCBs, or dioxin/furans meeting the criteria discussed above. The soil from these areas can be presumed to be remediated and will be addressed in forthcoming remedial planning.

Risk Assessment

Risks were estimated for both potential future human receptors (assuming a future recreational site use) and ecological receptors for two exposure units (EUs), OU-A North and OU-A South, that are geographically separated areas of OU-A. The risk assessments were conducted under the assumption that the five PRAs discussed above (two in OU-A North and three in OU-A South) have been targeted for remediation. Chemicals detected and identified as constituents of potential concern (COPC), which included VOCs, TPH, PAHs, dioxins/furans, and metals above background levels, were evaluated and exposure point concentrations (EPCs) equivalent to the 95th upper confidence level on the mean (95% UCL) were used to estimate risks. Soils down to 10 feet bgs were assessed, with the higher concentrations generally in the 0- to 0.5-foot bgs interval.

All methods followed the *Site-Wide Risk Assessment Work Plan* (ARCADIS BBL, 2007h). Human receptors evaluated included future recreators, and construction and maintenance/utility workers. Ecological receptors evaluated included plants (including special-status species), soil invertebrates, and representative wildlife receptors (birds and mammals).

Exposure pathways for human receptors included: incidental soil ingestion, dermal contact with soil, and inhalation of vapors and particulates. Both a central tendency estimate (CTE or “average”) and a reasonable maximum exposure (RME or more conservative) scenario were evaluated for each human receptor.

Ecological receptor pathways included direct contact (for plants and invertebrates) and the ingestion of soil and prey by wildlife. Site-specific information on uptake of dioxins/furans into plants and soil invertebrates was utilized. Ecological receptors were assessed through a screening-level approach that used maximum detected concentrations and through a baseline ecological risk assessment (BERA) that used the estimated EPCs for the two exposure units (OU-A North and OU-A South) and more reasonable assumptions of exposure. Risks were estimated using low toxicity reference values (TRVs), which are more conservative no-effects levels, and high TRVs, which are typically low-effects levels (concentrations or doses above which adverse effects are more likely to occur). Comparisons to high TRVs under the BERA are generally more useful for risk-management decision-making.

Human Health Results

All noncancer estimates for OU-A were below the agency threshold of one for noncancer hazard index (HI) effects and below the 10 micrograms per deciliter ($\mu\text{g}/\text{dl}$) blood-lead level for each of the receptors under all scenarios.

Arsenic accounts for over 90% of the total cancer risk estimates at OU-A; however, the arsenic EPCs are well within ambient/background conditions. With the exception of the recreator receptors, the CTE cancer risk estimates in both EUs were below California Environmental Protection Agency’s (CalEPA’s) threshold of 1×10^{-6} for carcinogenic effects, even with arsenic included. All risks for all receptors were below 1×10^{-6} once arsenic was excluded. The threshold of 1×10^{-6} was exceeded in both EUs for both the RME and CTE scenarios for the recreator and the RME scenario for the construction and maintenance/utility workers only when background levels of arsenic are included.

Based on this assessment, site-related chemicals do not pose an unacceptable risk to future receptors in OU-A. As discussed previously, risk estimates are based on the assumption that five PRAs are addressed through remediation.

Ecological Results

The results of the ecological risk assessment indicate that risk calculations conducted for a number of receptors using maximum concentrations (screening level assessment), low toxicity values, or conservative screening-level benchmarks resulted in hazard quotients (HQs) greater than one (HQs>1), indicating the potential for risk.

However, when more reasonable assumptions and high toxicity values were used, HQs were all equal to or less than one. Additionally, incremental exposure (as compared to ambient/background) is not indicated for any of the receptors with low toxicity values or screening-level benchmark HQs greater than one (based on comparisons of EPCs to site background levels).

Evaluation of special-status plants showed that isolated soil concentrations for a few metals (chromium, vanadium, and zinc) exceed conservative phytotoxicity benchmarks for soil and site-specific soil background levels. However, the phytotoxicity benchmarks are also exceeded by background soil concentrations by as much as 60 times. If only surface soils (0 to 0.5 foot bgs; the typical root depth of the relevant special-status species) are evaluated, chromium is only slightly above background at one location, vanadium is below background at all locations, and the maximum zinc concentration is less than twice background. Slightly higher concentrations were found in the 0- to 2-foot bgs interval, but in isolated areas.

Given the results of the ecological risk assessment and uncertainties associated with the phytotoxicity benchmarks used to assess special-status plant species, the results of the ecological risk assessment indicate that additional management actions beyond the planned PRAs are not warranted.

Overall Summary

This RI Report provides sufficient characterization of the nature and extent of COIs within OU-A. Five PRAs were identified as appropriate for remedial action based on factors that included the presence of hazardous waste (lead), PCBs above the TSCA threshold, or areas considered "hot spots" with concentrations of chemicals over 10 times screening levels. Based on the assessment of risks following assumed

remediation of the PRAs, risks are predicted to be within the acceptable range. The five PRA areas will be carried forward into the remedial planning process. No other areas warrant further evaluation.

1. Introduction

This Remedial Investigation Report (RI Report) for Operable Unit A, the Coastal Trail and Parkland Zone (OU-A), was prepared by ARCADIS BBL on behalf of Georgia-Pacific LLC (Georgia-Pacific) for the former Georgia-Pacific Wood Products Facility (site) located at 90 West Redwood Avenue, Fort Bragg, Mendocino County, California (Figure 1-1). This RI Report is a component required by the Department of Toxic Substances Control (DTSC) under Section 5.4 of the Site Investigation and Remediation Order for the site (Docket No. HSA-RAO 06-07-150; the Order). This RI Report also includes human health and ecological risk assessments as required in Section 5.6 of the Order.

The approximately 415-acre site is located west of Highway 1 along the Pacific Ocean coastline and is bounded by open coastline to the north, Noyo Bay to the south, the City of Fort Bragg (City) to the east, and the Pacific Ocean to the west. According to historical records, Union Lumber Company (ULC) began sawmill operations at the site in 1885. Georgia-Pacific acquired the site in 1973 and ceased lumber operations on August 8, 2002. Much of the equipment and structures associated with the lumber production have since been removed. Industrial operations at the site included lumber production and power generation by burning residual bark and wood.

OU-A is defined in the Order as an approximately 100- to 110-foot-wide pathway that traverses portions of the following Assessor's Parcel Numbers primarily along the top of the coastal bluff: 008-010-26-00, 008-020-09, 018-430-01-0-0, 018-430-02-00, 018-430-07-00, and 018-120-44. In addition, OU-A includes an approximately 30-acre parkland area located within the western portions of Assessor's Parcel Numbers 018-430-01-0-0 and 018-430-02-00. The western boundary of OU-A is the mean high tide line. The area west of the mean high tide line belongs to California State Lands Commission. The total acreage of OU-A is approximately 87 (Figure 1-2).

1.1 Objectives

According to the Order, "the purpose of the RI is to collect data necessary to adequately characterize the Site for the purposes of defining risks to public health and the environment and developing and evaluating effective remedial alternatives for foreseeable land uses" and "identify the sources of contamination and define the nature, extent, and volume of the contamination." The Order also states that this information should be used to evaluate contaminant fate and transport. The Order further indicates that the RI should contain the following:

(a) Site Physical Characteristics. Data on the physical characteristics of the Site and surrounding area shall be collected to the extent necessary to define potential transport pathways and receptor populations and to provide sufficient engineering data for development and screening of remedial action alternatives.

(b) Sources of Contamination. Contamination sources (including heavily contaminated media) shall be defined. The data shall include the source locations, type of contaminant, waste characteristics, and Site features related to contaminant migration and human exposure.

(c) Nature and Extent of Contamination. Contaminants shall be identified and the horizontal and vertical extent of contamination shall be defined in soil, groundwater, surface water, sediment, air, and biota. Spatial and temporal trends and the fate and transport of contamination shall be evaluated.

Data used in this RI Report to provide the components listed above were compiled from existing data (as presented in the Current Conditions Report [CCR]; BBL, 2006) and data recently collected in accordance with the following: the *Site Investigation Work Plan, Operable Unit A, Coastal Trail and Parkland Zone* (ARCADIS BBL, 2007i); an addendum to this work plan that incorporated agency comments from a meeting held in April 2007 (ARCADIS BBL, 2007j); additional data collection requirements specified in a letter from DTSC dated April 17, 2007 (DTSC, 2007); and a further clarification letter dated April 23, 2007 (ARCADIS BBL, 2007k). Some additions and modifications to the sampling approach were also made based on verbal consultations between ARCADIS BBL and DTSC throughout the investigation; these changes are discussed in Section 4. The data proposed in the work plan documents were collected, as well as additional data that resulted from discussions with DTSC. To the extent applicable, this RI Report includes the components discussed above as they relate to the data collected in the recent and historic investigations for OU-A.

This RI Report also includes both human health and ecological risk evaluations utilizing historic and recently collected data. In accordance with the Order, the evaluations follow relevant U.S. Environmental Protection Agency (USEPA) and California Environmental Protection Agency (CalEPA) guidance documents.

The information presented herein will be used in forthcoming remedial planning documents for OU-A.

1.2 Report Organization

The remainder of this work plan is organized as follows:

Section 2, Site Description and Background. This section provides information on the site setting, background, and history for OU-A, as well as a summary of previous investigations.

Section 3, Conceptual Site Model. This section provides a summary of the chemicals of interest (COIs) for OU-A, fate and transport information, and discusses potentially exposed receptors and potentially complete exposure pathways.

Section 4, Investigation Summary. This section provides a summary of the 2007 investigation work and a data quality assessment.

Section 5, Nature and Extent of Contamination. This section provides information on the results of current and previous investigations and describes the horizontal and vertical extent of contamination.

Section 6, Risk Assessments. This section provides the assessments of human health and ecological risks.

Section 7, Summary and Recommendations. This section provides a summary of findings and recommendations related to risk assessment and remedial planning.

Section 8, References. This section lists the sources of information cited in this Report.

The following appendices provide supporting information:

Appendix A, Data Summary Tables

Appendix B, Boring and Pothole Logs and Field Notes

Appendix C, Photographs

Appendix D, Laboratory Reports

Appendix E, Dioxin Profiles

Appendix F, Evaluation of the Uptake of Dioxins/Furans by Biota

Appendix G, Statistical Methods and ProUCL Output Tables

Appendix H, Human Health Risk Assessment Dose and Risk Tables

Appendix I, Ecological Risk Assessment Dose and Risk Tables

2. Site Description and Background

The CCR (BBL, 2006) provided a summary of the site setting, history, operational practices, and previously collected data for the entire site. This RI Report summarizes that information as it pertains specifically to OU-A. Previous site investigations were conducted by dividing the site into 10 parcels for investigation and evaluation (Figure 1-2). OU-A includes portions of the following six parcels:

- Parcel 1: North Coast
- Parcel 3: Industrial
- Parcel 6: Planer
- Parcel 7: Sawmill #2
- Parcel 8: Log Storage
- Parcel 10: South Coast

As shown in Figure 1-2, OU-A includes two geographically separate units that will be referred to as OU-A North (22 acres) and OU-A South (65 acres). OU-A North includes the western portion of Parcel 1 and the southwestern corner of Parcel 3. OU-A South includes small portions of Parcels 6 and 7, where the future trail corridor borders the City Wastewater Treatment Plant; a portion of Parcel 8; and most of Parcel 10. OU-A North is largely paved and disturbed. In contrast, OU-A South is largely unpaved.

For purposes of discussion, each of the geographic units within OU-A (OU-A North and OU-A South) was further subdivided into smaller areas of interest (AOIs) based on historical usage, previous investigations, and sampling recommended in the *Site Investigation Work Plan* (ARCADIS BBL, 2007i). These AOIs are shown on Figures 2-3 and 2-4 and include:

- Glass Beach 1 (OU-A North, Parcel 1)
- Between Glass Beach 1 and Glass Beach 2 (OU-A North, Parcel 1)
- Glass Beach 2 (OU-A North, Parcel 1)

- Between Glass Beach 2 and Glass Beach 3 (OU-A North, Parcel 1)
- Glass Beach 3 (OU-A North, Parcel 1)
- East of Glass Beach 3 (OU-A North, Parcel 1)
- Parcel 3 Scrap Yard/Geophysical Anomaly Area (OU-A North, Parcel 3)
- Parcels 6 and 8 Coastline (OU-A South, Parcels 6 and 8)
- North of Parcel 8 Clinker Area (OU-A South, Parcel 8)
- Parcel 8 Clinker/Fill Area (OU-A South, Parcel 8)
- Parcel 10 Geophysical Anomaly/Clinker Area (OU-A South, Parcel 10)
- Parcel 10 Fill Area (OU-A South, Parcel 10)
- Former Railroad Tracks (OU-A South, Parcel 10)
- Blowhole (OU-A South, Parcel 10)
- Parcel 8 Fill Area (OU-A South, Parcel 8)
- North of Native American Homes (OU-A South, Parcel 8)

2.1 Climate

Western Mendocino County has a relatively mild climate with abundant rainfall. Cool, moist air over the Pacific Ocean has a profound influence on regional temperatures. Temperatures remain cool throughout the year, with average annual air temperature ranging from 53 to 57 degrees Fahrenheit (°F). At Fort Bragg, the difference in the average temperature of the coolest month (January) and the warmest month (September) is only 8°F. Marine air also minimizes the difference between daytime and nighttime temperatures; at Fort Bragg, the variation between average high and average low temperatures for August is 15°F (Natural Resources Conservation Service [NRCS], 2002).

Precipitation varies between 35 to 80 inches per year and occurs mostly from October through April. The lesser amounts occur along the immediate coast near Fort Bragg and Point Arena. Marine fog commonly occurs in coastal areas, especially during the nearly rainless summer months. The average annual frost-free season ranges from 150 to 365 days. Snowfall is rare at low elevations but averages 15 inches or more at the higher elevations west of Laytonville and east of Leggett (NRCS, 2002).

Mean wind speed in the area ranges from 5 to 8 miles per hour and the prevailing wind direction is generally north-northeast in the summer and east-southeast in the winter.

2.2 Geology and Hydrogeology

Fort Bragg is located along the northern California coastline within the Coast Range geomorphic province. The regional geology consists of complexly folded, faulted, sheared, and altered bedrock. The bedrock of the region is the Franciscan Complex (Complex) of Cretaceous to Tertiary (late Eocene) age (40 to 70 million years old). The Complex consists of a variety of rock types. In the north coast region the Complex is divided into two units, the Coastal Belt and the Melange. In Mendocino County, the Melange lies inland and is an older portion of the Complex, ranging in age from the Upper Jurassic to the late Cretaceous. The Coastal Belt consists predominantly of greywacke sandstone and shale.

This geologic province formed at the boundary between the North American and Pacific Plates. The contact between the North American and Pacific Plates is currently the San Andreas Fault Zone and subsidiary faults. Relative to the site, the San Andreas Fault is offshore about nine miles. The Coastal Belt has undergone weak to intensive deformation, which has included folding, uplifting, tilting, and overturning. Also of importance to the seismicity of the region is the Mendocino Triple Junction, the terminus of the San Andreas Fault, which is located in the Cape Mendocino area approximately 80 miles to the north-northwest of Fort Bragg. This boundary represents the point at which the San Andreas Fault, the Mendocino Fracture Zone, and the Cascadia Subduction Zone meet. It is an extremely active tectonic and seismic zone and earthquakes have occurred frequently in the area.

Other geologic units present in Fort Bragg and the vicinity include surface geologic units, including deposits of beach and dune sands, alluvium, and marine terrace deposits. The most important of these at the site are the marine terrace deposits of Pleistocene age, which cut bedrock surfaces along the coast and form much of the

coastal bluff material overlying bedrock. The marine terrace deposits are massive, semi-consolidated clay, silt, sand and gravel, ranging from 1 to 140 feet in thickness.

The surficial geology of the site and environs is depicted in Figure 2-1. The site is underlain by Quaternary (less than 1.5 million years old) terrace sediments deposited on wave-cut surfaces parallel to the coast (BCI, 2006). The terrace was created during the Pleistocene Epoch when sea-level fluctuations caused by glaciation created a series of terraces cut into the Franciscan bedrock by wave action (BACE Geotechnical, 2004). The terrace deposits consist of poorly to moderately consolidated marine silts, sands, and gravels and are overlain by a 3- to 4-foot-thick mantle of topsoil. The terrace soils are underlain by Tertiary-Cretaceous marine sediments (approximately 65 million years old) of the Coastal Belt Franciscan Formation, composed of well consolidated sandstone, shale, and conglomerate. Currently, the bluffs at the site range from 0 to 80 feet in height (BACE Geotechnical, 2004).

The topsoil, terrace deposits, and Franciscan Formation are each exposed within the bluff face throughout the site. The topsoil is dark brown to black silty and clayey sand. The terrace soils consist of partly cemented, tan and orange-brown, sandy silt, with occasional lenses of cemented pebbly sand. The total thickness of the topsoil and terrace units typically varies from about 5 to 30 feet; in places, up to 20 feet of this can consist of emplaced fill (BACE Geotechnical, 2004). The strength and competency of the terrace materials are demonstrated by near-vertical slopes that are common throughout the bluffs (BCI, 2006).

The marine terraces contain strong, northwesterly trending structural features, including an unnamed, concealed fault south of the site. These features are parallel to the more regional fault traces, such as the San Andreas Fault west of the site (BACE Geotechnical, 2004; BCI, 2006). Several inactive faults and one potentially active fault have been observed in the bluffs at the site. BACE Geotechnical (2004) noted that the inactive faults consist of linear fractures or shear zones displaying evidence of offsets within the Franciscan bedrock, but not within the overlying terrace deposits. The potentially active fault crosses a small, narrow peninsula within the northern bluffs; however, there is no evidence of movement along the fault within the last 11,000 years. No landslides are observed onsite and no evidence of deep-seated, rotational landsliding was observed on the bluffs at the site (BACE Geotechnical, 2004).

The regional hydrogeologic setting of the Mendocino County coast has been described in the *Mendocino County Coastal Ground Water Study* (California Department of Water Resources, 1982). The site is in the western coastal area of the county, which was

divided into five subunits in the study: Westport, Fort Bragg, Albion, Elk, and Point Arena; these areas are separated by the major rivers that discharge to the Pacific Ocean. The areal extent of the study included those areas in which coastal terrace deposits had been mapped. The site is located within the Fort Bragg subunit, which extends from Big River on the south to Ten Mile River on the north.

Fresh groundwater is primarily obtained from shallow wells in the semiconsolidated marine terrace deposits or through municipal or privately owned water systems. These water systems divert surface flow and springs or tap shallow alluvial aquifers. A combination of wells and surface water diversions is commonly necessary to provide adequate supply year round.

Groundwater was encountered between 11.5 and 11.7 feet below ground surface (bgs) in borings advanced in March 2003 in Parcel 1 in the northern portion of OU-A (P1-1, P1-2, and P1-5). In the southern portion of OU-A, depth to water has in the past been encountered as shallow as 7.07 feet bgs in MW-10.2 to as deep as 27.42 feet bgs in MW-10.4. Hydrographs for the four monitoring wells are shown in Figures 2-1a through 2-1d with quarterly groundwater levels shown from January 2004 through June 2007. The maximum groundwater fluctuation in these wells is slightly over 4 feet, from an elevation of 60 feet above mean sea level (amsl) to slightly above 64 feet amsl in MW-10.2. The highest groundwater levels occur in the spring (March) and the lowest in the fall (September and December).

Generally, monitoring data and topographic gradients demonstrate that onsite groundwater flow is primarily to the west-southwest toward the Pacific Ocean as shown on Figure 2-1e. This figure shows a radial pattern of flow towards Soldier Bay in the central portion of the site but generally westward flow towards the ocean. Additional information on groundwater elevations is provided in the CCR (BBL, 2006) and in the most recent groundwater monitoring report (ARCADIS BBL, 2007g).

The principal natural hydrological sources for the site are precipitation, surface runoff from adjacent lands, and stormwater discharge from the City. Most of the hydrological features at the site are manmade; the natural hydrology has been significantly changed by over a century of mill operation.

The *Soil Survey for Mendocino County, California, Western Part* (NRCS, 2002) depicts the entire site as Urban Land, which is defined as being covered by approximately 60% paved surface containing landscaped areas and areas that have been graded for

urban development. Urban Land is not assigned a soil taxonomic group or drainage class, as drainage is highly variable in urban areas.

2.3 Biological Setting

The sections below provide brief descriptions of the habitat types, plant communities, and animal species within or likely to occur within OU-A. A detailed description of ecological resources found in OU-A is provided in the ecological risk assessment (Section 6).

2.3.1 Habitats

OU-A consists primarily of upland habitat, most of which can be classified as highly disturbed habitat. The majority of the upland habitat is covered in non-native grasses, asphalt, and/or industrial development. Other habitat types present in OU-A include northern coastal bluff scrub and a small area of coastal terrace prairie (Figure 2-2; Wetlands Research Associates [WRA], 2005). There is a limited amount of wetland habitat (e.g., riparian wetland) present in the southern portion of OU-A, located in Parcel 8 and fed by site drainages. This habitat's ability to support a rich ecosystem is limited because of its small size (approximately 1 acre). Higher quality habitat is confined almost entirely to land immediately adjacent to the shoreline. Additional discussion of habitats present within OU-A is provided in the ecological risk assessment (Section 6).

2.3.2 Flora and Fauna

The plant community in OU-A is composed primarily of grasses and scrub brush. There are isolated areas of wetland plants in the southern portion of OU-A in the small riparian wetland area. The only trees within OU-A are those around the Native American homes in OU-A South. Additional discussion of plant communities present within OU-A is provided in the ecological risk assessment (Section 6).

Invertebrates that utilize the terrestrial habitat include annelids, snails, spiders, and several insect families including flies, beetles, and grasshoppers/crickets. Mammals observed onsite vary considerably in size, ranging from small rodents to mule deer. Avian species represent the most common feeding guilds and include herbivorous, carnivorous, piscivorous, and invertivorous species. Wetland birds have been observed, but are scarce because of the limited wetland habitat present in OU-A; their presence is likely because of the proximity to more substantial wetland areas in OU-E.

A detailed description of wildlife observed in, or likely to occur within, OU-A is provided in the ecological risk assessment (Section 6).

2.4 Cultural Resources

TRC Companies, Inc. (TRC, Undated #1; Undated #2; 2003) conducted archival research and cultural resource surveys for the entire site within the property's period of significance, considered to be 1885 to 1953 (50 years from the date of the report). TRC (2003) found that:

- Portions of the property are considered likely to contain intact prehistoric deposits.
- The property also contains three historic sites and areas that are likely to contain historic deposits that are important in understanding the early settlement and development of the local community as well as the lumber operations on the property.

The Site Specific Treatment Plan (TRC, Undated #2) concluded that specific areas contain a moderate to high potential for subsurface historic cultural resources and recommended that an archaeologist and Native American representative be present during any intrusive work performed to characterize the cultural resources. Additional work was conducted in 2006 by Garcia and Associates (GANDA) related to mitigation and monitoring requirements in the California Coastal Commission Coastal Development Permit (CDP) for the foundation removal and bluff work in 2006; GANDA's investigation confirmed the previous sites and found a new pre-historic site, all within OU-A. The sites consist of low to moderately dense shell middens along with associated artifacts. Consequently, intrusive work in the shoreline area of OU-A requires monitoring and/or recovery activities by archaeologists and Native American representatives.

2.5 Operational History

In addition to the CCR (BBL, 2006), the following documents were used to summarize site conditions and data:

- Phase I Environmental Site Assessment (ESA) (TRC, 2004b)
- Phase II ESA (TRC, 2004c)

- Work Plan for Additional Site Assessment (TRC, 2004d)
- Additional Site Assessment Report (TRC, 2004e)
- Groundwater Monitoring Reports, Third Quarter 2004 through First Quarter 2007 (TRC, 2004f; 2005; Acton•Mickelson•Environmental, Inc. [AME], 2005e,f,g; 2006b,c,f; ARCADIS BBL, 2007a,e,g)
- Work Plan for Additional Site Assessment (AME, 2005c)
- Dioxin Sampling and Analysis Report (AME, 2006d)
- Data Transmittal Report (AME, 2006e)
- Background Metals Report (ARCADIS BBL, 2007c)
- Distribution and Sources of Polychlorinated Dibenzo-*p*-Dioxins and Polychlorinated Dibenzofurans (ARCADIS BBL, 2007d)
- *Comprehensive Monitoring Plan* (ARCADIS BBL, 2007f).

Additional information was obtained through interviews with current site personnel (Paul Johnson and Doug Heitmeyer).

AOIs (areas where historical activities could have resulted in a release of hazardous substances) are described below with respect to past operational practices. Site features are shown on Figures 2-3 and 2-4. The major site-related use of the areas within OU-A was log and untreated lumber storage. As described in the CCR (BBL, 2006) and elsewhere, logs received and milled onsite were overwhelmingly restricted to redwood, with just a few years where a small amount of fir was taken in. Redwood does not require wood treatment or the use of pesticides. There is no record of pesticide use onsite (with the exception of the plant nursery in Parcel 9). The precise amount of pentachlorophenol-based products used historically is unknown (treatment using chromated copper arsenate did not occur onsite), but **is** expected to be minor because redwood, as stated above, **does** not need such treatment. Historic uses of pentachlorophenol-based products were limited to a small portable dip tank in the eastern portion of Parcel 3 and also near the Green Chain (a former conveyor that transported wood from the sawmill to lumber storage areas), with both areas

operational for up to three years. Both these areas are east of and outside the boundary of OU-A. Lumber associated with the limited wood-treating practices was specifically stored near those locations and not within OU-A (personal communications with Paul Johnson and Doug Heitmeyer, January 2007).

2.5.1 OU-A North

OU-A North consists of portions of former Parcels 1 and 3. Results from previous investigations associated with these parcels are summarized in the following sections. The AOIs in OU-A North are shown on Figure 2-3.

2.5.1.1 Glass Beaches (Parcel 1)

Prior to 1949, the formal ownership of Parcel 1 is uncertain, but provincial knowledge (solicited from long-term residents) indicates that a golf course (called the "City Golf Course" by locals) was on the majority of Parcel 1 for some period. Georgia-Pacific is currently researching the formal property ownership prior to 1949. Parcel 1 was purchased by ULC and belonged to the mill starting in 1949. From 1949 to 1967, the property immediately to the north of the site within Glass Beach 1 (currently the southern end of MacKerricher State Park) and Glass Beach 2 was used by the surrounding community as a dump for the disposal of household waste, scrap metal, and automobiles. Waste was discharged both directly into the ocean and placed into pits for burning and burial. The mill facility did not have direct access to either Glass Beach 1 or 2 due to a fence line that restricted access from either side. The northwestern corner of OU-A includes the southwestern corner of the former Glass Beach 1 dump; debris is visible on the bluff faces in this area. Glass Beach 2, also a former dump, is in the middle and south of Parcel 1.

The area referred to as Glass Beach 3, which is near the southern portion of Parcel 1, has always been a part of the mill property and had a fence line that restricted public access.

The City and the Blinn Trust completed a cleanup of the offsite (north) portion of Glass Beach 1 under a Corrective Action Plan approved by the Regional Water Quality Control Board (RWQCB; Order No. R1-2002-0099). The onsite portion of Glass Beach 1 was not part of the cleanup effort. The northern portion of Glass Beach 1 that was the subject of the cleanup order was distinctly different than the southern portion on the mill site property because of the presence of actual buried cells with refuse; areas of buried refuse have not been found on the mill site portion (TRC, 2004b,c,e).

Glass Beaches 2 and 3, as indicated above, were also used as public and private dumps. Some disposal of materials associated with the mill, mainly construction debris, occurred in Glass Beach 3. However, the majority of the disposal was from the community and only a fraction from the mill site.

Melted metal fused with native rock has been observed at all three areas, well below the mean high tide line and outside of the legal boundaries of the site. Metallic debris below the ground surface was found only at a shallow (1 foot deep or less) depth and only at Glass Beach 3. Other debris is limited to that which can be observed protruding from the coastal bluffs (buried debris does not extend inland). No buried debris was found at Glass Beaches 1 or 2. It should be noted that construction/metallic debris is not in and of itself a hazardous substance; its presence on the bluffs is mainly an aesthetic and safety issue.

Prior to the 1960s, an explosives storage shed was located near Glass Beach 2. The former explosives storage shed was approximately 50 feet north of the current Explosives Bunker (Figure 2-3), which was used from the 1930s through the 1960s to store dynamite, blasting caps, fuses, and possibly nitroglycerin. These materials were not actually used onsite, but rather were exclusively employed to break up log jams at offsite locations.

2.5.1.2 Parcel 3 Former Scrap Yard/Parcel 3 Geophysical Anomaly Area

The southwestern portion of Parcel 3, formerly known as the Scrap Yard, is included in OU-A. The Scrap Yard was used starting in approximately 1995; prior to that time, the area was used to store untreated lumber (as discussed previously, lumber was not treated nor was treated lumber stored in this area). From 1995 until the facility was decommissioned, this area was used to store various metal scrap debris, including metal scrap, metal buckets, piping, chains, fencing, plastic, car parts (e.g., engine blocks, doors, seats), and pieces of transformers. Scrap and debris were also observed at the edge of the cliff as well as in the surf area below. Since the decommissioning of the facility, the scrap and debris have been removed. A geophysical investigation was performed in this area in 2004 to identify potential waste deposits and anomalies were identified (TRC, 2004e). The Scrap Yard and extent of the geophysical investigation are shown on Figure 2-3.

2.5.2 OU-A South

OU-A South consists of portions of former Parcels 6, 8, and 10. Previous investigations associated with these parcels are summarized in the following sections. The AOIs in OU-A South are shown on Figure 2-4.

2.5.2.1 Parcel 6 and 8 Coastline

The southernmost portion of the Log Pond West Fill Area in Parcel 6 was filled between 1966 and 1973. The area between the City Wastewater Treatment Plant and the western extent of the Log/Mill Pond was filled after 1982 (AME, 2005c). According to TRC (2004a) and based on interviews with facility personnel, the fill in the southwestern portion of the Log/Mill Pond was provided by scraping soil in the northern storage areas (Parcel 1). Another report (TRC, 2004b) notes that the fill consisted of bricks, wood, and heterogeneous materials. Only a small portion of OU-A crosses this Fill Area.

2.5.2.2 Clinker/Ash Scrap Piles (Parcels 8 and 10)

The clinker piles were made up of clinker and ash waste materials from the powerhouse along with scrap metal from facility operations. Clinker is a slag-like material that was removed from the bottom of the boilers. The former extent of these piles in the western portion of Parcel 8 and northeastern portion of Parcel 10 are shown on Figure 2-4. These piles have been removed since the facility was closed and the material was reused as roadbase offsite. Some residual clinker can be observed on the surface.

2.5.2.3 Parcel 10 (Parcel 10 Geophysical Anomaly and Fill Areas)

OU-A contains most of Parcel 10, which occupies approximately 50 acres along the southwestern portion of the site. The majority of this parcel was not used for sawmill operations. Scrapings from the log storage area in Parcel 10 were apparently pushed to an area north of the Blowhole (a natural feature located on the southwestern portion of this parcel). Other areas in Parcel 10 were also used as fill areas. A geophysical survey identified anomalies in the northern portion of the parcel that were proposed for investigation/excavation (AME, 2005a). The investigation area is shown on Figure 2-4. Potholes identified in the geophysical survey showed buried debris in the large Fill Area in the southern portion of Parcel 10.

2.5.2.4 Parcel 8 Fill Area

Parcel 8 (largely used for storage of untreated log and untreated lumber) included an area of disturbance along the coastal region at the south end of the parcel known as the Fill Area. Figure 2-4 shows the approximate extent of the Parcel 8 Fill Area.

2.5.2.5 Blowhole

The Blowhole is a natural feature located in the southwestern portion of Parcel 10 (Figure 2-4). Scrapings from the log storage area in Parcel 10 were apparently disposed in an area north of the Blowhole and pushed into the Blowhole. Debris was observed in the Blowhole and along the cliff line near the feature, including burned debris.

2.5.2.6 Former Railroad Tracks

Prior to the 1950s, rail lines extended to the southwestern tip of Parcel 10 (and would have crossed through the southernmost portions of Parcels 8 and 10) (TRC, 2004b). The rail lines were presumably used to transport logs and untreated lumber. The rail lines are no longer present in this area.

2.5.2.7 Runway

A runway is located near the border between Parcels 8 and 10; only the northern portion of the runway is within OU-A. The airstrip was constructed sometime between 1941 and 1952 and was used up until the late 1980s. Jet fuel was used for a short time to refuel planes in the refueling area, which is within Parcel 8, but outside the boundary of OU-A. Historical accounts indicate that transport trucks refueled airplanes directly on the pad during the operation of the runway (AME, 2005c); therefore, there was no need for underground tanks. To confirm that no USTs were present, a geophysical survey was conducted yielding no evidence of USTs in this area.

2.6 Summary of Previous Investigations

The sections below provide a summary of previous investigations conducted within the specific AOIs discussed above. As shown in Figure 1-2, OU-A includes two geographically separate units that are referred to as OU-A North (22 acres) and OU-A South (65 acres). OU-A North includes the western portion of Parcel 1 and the southwestern corner of Parcel 3. OU-A South includes small portions of Parcels 6 and

7 where the future trail corridor borders the City Wastewater Treatment Plant, a portion of Parcel 8, and most of Parcel 10. OU-A North is largely paved and disturbed. In contrast, OU-A South is largely unpaved.

A change in lead regulatory oversight from RWQCB to DTSC occurred in August 2006. Investigations and reports performed prior to this date were overseen and approved by the RWQCB with all those following this date submitted to the DTSC as the lead agency.

2.6.1 Phase I Environmental Site Assessment (TRC, 2004b)

During site reconnaissance activities conducted for the Phase I ESA, TRC (2004b) observed debris, scrap metal, concrete retaining walls, piping, and areas of staining along the cliffs above mean high tide in the Glass Beach Areas. Areas of melted debris fused with the native rock formations are present in areas below mean high tide (offsite) at Glass Beaches 1 through 3. The majority of the debris on the beach areas themselves (which are all offsite) consisted of polished glass and was not considered an environmental concern. Debris is currently visible at or near the top of the bluffs. Removal of debris above the mean high tide line has been completed for potential safety and aesthetic reasons only.

Within the Scrap Yard in Parcel 3, various debris was noted during site reconnaissance activities. The debris, which included metal and plastic materials, engine blocks, and transformer pieces, has since been removed from this area.

During a review of historical aerial photographs, large disturbed areas were noted along the coastline near the cemetery in Parcel 8. An investigation was recommended in the Phase I ESA (TRC, 2004b) in the airstrip fueling area (south end of airstrip), clinker piles, and the disturbed areas along the coastline for metals, total petroleum hydrocarbons as diesel (TPHd), and total petroleum hydrocarbons as motor oil (TPHmo). A recommendation was made to perform this investigation by trenching the identified areas and collecting representative soil samples and logging visual findings.

Site reconnaissance activities in Parcel 10 revealed the presence of debris in the Blowhole and along the bluffs. Fill was observed in the area north of the Blowhole. Abandoned metal debris, stained cliffs, and a small area of melted debris fused with the native rock formation were observed along the area identified as disturbed in historical aerial photographs. Large clinker and ash/scrap piles were observed on the northeast portion of Parcel 10. Based on these findings, a recommendation was made

to investigate the Blowhole area, the clinker and scrap piles, and the disturbed areas identified in aerial photographs for metals, TPHd, TPHmo, and polychlorinated biphenyls (PCBs) by excavating test pits through the areas and collecting representative soil samples and logging visual findings.

2.6.2 Phase II Environmental Site Assessment(TRC, 2004c)

2.6.2.1 Glass Beaches (Parcel 1)

In 2003, TRC (2004c) collected a total of 29 soil samples (9 from Glass Beach 1, 8 from Glass Beach 2, and 12 from Glass Beach 3) and 3 groundwater grab samples from 15 borings advanced up to a maximum depth of 19 feet bgs in Parcel 1 in the vicinity of the Glass Beach Areas. Samples, in general, were collected from these borings from depth intervals of 1 to 1.5 and 5 to 5.5 feet bgs at each location to assess the soils for chemical contaminants associated with debris along the shoreline. Approximately half of the samples were collected in paved areas. For those samples in unpaved areas, surface soil was not collected. In paved areas, the first depth interval is at the first soil encountered (note that depths have been corrected to depth bgs, defined as the first soil surface). Soil samples were analyzed for all of the following: TPHd, total petroleum hydrocarbons as gasoline (TPHg), TPHmo, metals, semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs). Additionally, 12 of the samples were analyzed for PCBs and pesticides. Groundwater samples were analyzed for total petroleum hydrocarbons (TPH), dissolved metals, SVOCs, and VOCs. The only debris noted in borings was trace glass in the surface soil at one location at Glass Beach 1.

In addition, 13 test pits were excavated by TRC to delineate possible buried debris in the areas. Test pits were completed to as deep as 11 feet bgs. There were five test pits advanced in Glass Beach 1 within OU-A (TP-5 through TP-9). Test pit TP-5 was located within the fenced Georgia-Pacific Lumber Storage Area in Parcel 1 in OU-A North. TP-6 through TP-9 were located west of the Georgia-Pacific fence line near the coastal bluffs. No soil samples were collected from any of these potholes. All five test pits excavated in this area were advanced to bedrock, and no subsurface debris or fill material was encountered (Appendix B).

At Glass Beach 3, NORCAL Geophysical Consultants (NORCAL, 2003) conducted a geophysical survey of an area covering approximately 180 feet east/west by 120 feet north/south (Figure 2-3; Appendix B). A terrain conductivity anomaly with relatively high soil conductivity was detected in the central-western portion of the surveyed area. The

anomaly represented an area with a significant change in its subsurface material and was consistent with potential landfill activities. In addition, a magnetic anomaly was discovered in the northwest corner of the survey area in an area where metal debris was observed protruding from the coastal bluffs. The magnetic anomaly was identified as likely representing additional buried metal debris. Four additional metal detector anomalies were identified in the survey area, consistent with shallow buried metal debris. Nine potholes (TP-1 through TP-9) were completed to bedrock in the Glass Beach 3 area to investigate the subsurface anomalies that were detected during the geophysical survey. No soil samples were collected from these potholes. Buried metal debris was encountered at one pothole location (TP-7) at 2.5 feet bgs (bedrock was encountered at 3 feet bgs). Other debris within the Glass Beach Areas was limited to surface debris visible along the coastline.

2.6.2.2 Parcel 3 Scrap Yard/Geophysical Anomaly Area

In March 2003, three surface soil samples (0 to 0.5 foot bgs) were collected from three borings (P3-1 to P3-3; Figure 2-3) completed to 3 feet bgs in the Parcel 3 Scrap Yard/Geophysical Anomaly Area and analyzed for metals, PCBs, TPH, and VOCs (TRC, 2004c). No debris was encountered.

2.6.2.3 Parcel 6 Fill Area

Although TRC (2004b) made no recommendations for the Parcel 6 Fill Area in its Phase I ESA, it was further investigated because it was determined to be a Fill Area. Eight potholes were excavated in the Fill Area; one of these potholes is located in the southern portion of the Fill Area within the boundaries of OU-A (P6-TP-2; Figure 2-4). Pothole P6-TP-2 was completed to a depth of 13 feet bgs. Metal wire, rebar, and wood were observed at a depth of 4 feet bgs. Bedrock was encountered at 10.5 feet bgs.

Four soil samples were collected from the eight potholes collected in the Fill Area and analyzed for metals, TPH, and SVOCs; however, no samples were collected from pothole P6-TP-2. Some wood and metal debris was observed in the potholes.

2.6.2.4 Parcel 10 Geophysical Anomaly/Clinker Area

One pothole (P10-PH2) was excavated in March 2003 to investigate subsurface soils near the Parcel Clinker and Ash Scrap Pile in the northern portion of Parcel 10 (Figure 2-4). At the time of the investigations, the clinker pile was present and extended to 3 feet above ground surface at test pit P10-PH2, which was excavated to 4 feet below

the top of the pile. Test pit P10-PH2 was excavated to a depth of 12 feet bgs. Wood chips and clinker were present near the top of the pile. Ash was present from the top of the pile to 1.5 feet below the top of the pile. One soil sample was collected from P10-PH2 and sampled for metals, TPH, SVOCs, and PCBs. As previously mentioned, the clinker pile has since been removed.

2.6.2.5 Parcel 8 Clinker/Fill Area

One pothole (P8-PH6) was excavated in March 2003 to investigate subsurface soils near the Clinker and Ash Scrap Pile that was present near the western boundary of Parcel 8. Pothole P8-PH6 is located in Parcel 8, but outside of the boundary of OU-A at the south end of the former clinker pile; it is discussed here only to provide additional information on the clinker area only. This pothole was excavated to 4 feet bgs; no debris was encountered. Three soil samples were collected from pothole P8-PH6 and analyzed for TPHd and TPHg. One of the samples was also analyzed for PCBs and metals.

2.6.2.6 Parcel 10 Fill Area and Blowhole

TRC (2004c) conducted an investigation consisting of 27 potholes (P10-PH1 and P10-PH3 through P10-PH28) in the Fill Material Area to provide information about depths of subsurface debris. The potholes extended to depths ranging from 3 to 11 feet bgs. A wide variety of debris was noted in these test pits, including wood, concrete, metal scrap, and ash. Paint cans were noted in one location (P10-PH14). Thirteen soil samples were collected from the potholes at depths ranging from 2 to 10.5 feet bgs and analyzed for metals, TPH, VOCs, SVOCs, and PCBs.

Four 4-inch monitoring wells (MW-10.1 through MW-10.4) were installed in the Fill Material Area. Eight soil samples collected during installation of these wells at depths ranging from 5 to 15.5 feet bgs were analyzed for TPH. Wood debris was noted in MW-10.3.

2.6.2.7 Parcel 8 Fill Area

Six potholes (P8-T1, P8-T2, P8-TP-1, and P8-PH1 through P8-PH3) were excavated to investigate suspected buried debris and/or fill material in a Fill Area in the southern portion of Parcel 8. These potholes were completed to depths ranging from 4 to 11 feet bgs. Debris was encountered in only one pothole, P8-T2; metal shavings were identified in soil excavated from 5 to 10 feet bgs. Trace clinkers were observed at

depths between 8 and 10 feet bgs. Four samples were collected from potholes P8-PH1, P8-PH3, P8-T1, and P8-T2 at depths ranging from 1 to 10 feet bgs and analyzed for TPHd, TPHg, metals, and PCBs.

2.6.3 2004 Investigations

2.6.3.1 Parcel 3 Scrap Yard/Geophysical Anomaly Area

In June 2004, TRC recommended that an additional assessment be conducted to identify whether soils containing TPHd were impacting groundwater (TRC, 2004d). In July 2004, TRC completed two potholes (P3-PH10 and P3-PH11; Figure 2-3) down to 8 to 12 feet bgs in the Parcel 3 Scrap Yard/Geophysical Anomaly Area (TRC, 2004e). Samples were collected from P3-PH10 and P3-PH11 at intervals of 1 to 2 feet and analyzed for TPH. No debris was identified in the potholes.

A geophysical investigation was conducted over a 4.6-acre portion of southern Parcel 3 in August 2004 (TRC, 2004e) to investigate potential debris deposit areas in the Former Scrap Yard shown on Figure 2-3. The geophysical investigation was conducted by performing EM61 (metal detector survey) and EM31 (ground conductivity survey) near subsurface anomalies. The geophysical survey report is provided in Appendix B of the *Site Investigation Work Plan* (ARCADIS BBL, 2007i). The anomalies were mainly identified in the western portion of the study area, adjacent to a sediment berm. The size and intensity of the anomalies did not suggest the presence of large buried metal objects. The uniformity in the ground conductivity survey indicated that no fill or reworked soils were present in the area. Additionally, test pits investigated by the archaeologists in 2006 showed that the depth of non-native soils in the area ranged from 0 to 16 inches. Small pieces of scrap metal were visible in the surface. On the basis of these findings and the historic use of the area for surface disposal/storage of scrap, it is likely that the anomalies correspond to smaller metal objects located near the surface or buried at shallow depths.

2.6.3.2 Parcel 10 Geophysical Anomaly/Clinker Area

A geophysical investigation was conducted over 8.1 acres in the northern portion of Parcel 10 in August 2004 to investigate potential waste deposit areas in the area of the Clinker and Ash/Scrap piles in the area shown on Figure 2-4. The investigation was contained within the boundaries of Parcel 10 and a portion of an offsite property to the north (Johnson Property). The area was centered around the portion of the former clinker piles in Parcel 10, but did not cover the areas where the piles extended into

Parcel 8, because those areas had already been investigated by potholing. The geophysical investigation was conducted by performing EM61 and EM31 surveys. The results indicated the presence of isolated buried metal objects and fill or reworked soils in this area. No significant surface metal or debris was noted within the survey area, with the exception of a large anomaly noted in the eastern portion of the area.

2.6.4 2005/2006 Investigations

2.6.4.1 *Glass Beaches (Parcel 1)*

The Explosive Bunker area (near Glass Beach 2) had no record of previous sampling and analysis. In 2005, AME advanced two direct-push soil borings, one immediately outside the door on the north side of the bunker and the other located 50 feet to the north in the area of the former wooden shed. The borings extended to bedrock, at 9 to 10 feet bgs (DP-1.3 and DP-1.4; see Figure 2-3). Soil was collected from two to three depth intervals per location to 8.5 feet bgs, and the samples were analyzed for nitrate and nitroglycerine. Charcoal and trace wood fragments were found in surface soil at one location, but no other debris was observed.

Also, a geotechnical investigation was conducted that included three geotechnical borings in each of the three Glass Beach Areas (GTB-1.1 to GTB-1.9; BCI, 2006; Figure 2-3). The borings extended to depths of 5.5 to 11.5 feet bgs penetrating the firm terrace and/or Franciscan bedrock material. In addition to samples for geotechnical analyses, soil samples were collected from at least two depth intervals from each boring and analyzed for TPH, metals, SVOCs, and/or VOCs. The first depth interval analyzed was from 2 to 2.5 feet bgs for each boring and only two locations were within a paved area. No debris was observed in the borings.

2.6.4.2 *Parcel 3 Scrap Yard/Geophysical Anomaly Area*

In May 2005, a proposal for future grid sampling in the area was submitted to the RWQCB. The chemical constituents that were selected for analysis included TPHd, TPHmo, VOCs, polycyclic aromatic hydrocarbons (PAHs), dioxins/furans, PCB congeners, and California Title 22 Metals (AME, 2005b). In September 2005, AME proposed to identify each anomaly by excavation (AME, 2005d; 2006a). This proposed work was completed during the implementation of the OU-A Work Plan and is discussed in Section 4.

In January 2006, six soil samples were collected at 2 and 6 feet bgs from three borings (GTB-1.10 to GTB-1.12; Figure 2-3) that were completed to 6.5 feet bgs in the Parcel 3 Scrap Yard/Geophysical Anomaly Area. The samples were analyzed for metals, TPH, VOCs, and SVOCs. These samples were collected as part of a geotechnical investigation, and a subset was analyzed to provide additional site characterization information. Red brick fragments were noted in surface soils at GTB-1.12.

Based on the historical use of the area as surface disposal/storage of scrap, the findings of the geophysical investigation, and the distribution of chemical concentrations in soil that exceed both screening levels and background levels, it is likely that the anomalies correspond to smaller metal objects located near the surface or buried at shallow depths.

2.6.4.3 Parcel 10 Geophysical Anomaly/Clinker Area

Ten borings (DP-10.1 to DP-10.10; Figure 2-4) were advanced at the piles in Parcel 10 by AME (2005c; 2006e) to approximately 10 feet bgs to characterize chemical concentrations in the clinker pile and underlying soil. The sample locations were chosen randomly from a systematic grid overlay at a spacing of approximately 15 feet. Wood, brick, and concrete (but not ash) were observed in the borings. Samples were analyzed for metals, SVOCs, VOCs, and TPH. Two samples were analyzed for dioxins/furans.

In January 2006, six soil samples were collected at 2 and 6 feet bgs from three borings (GTB-10.1 to GTB-10.3; Figure 2-4) that were completed to 6.5 feet bgs near or within the Parcel 10 Geophysical Anomaly/Clinker Area. The samples were analyzed for metals, TPH, VOCs, and SVOCs. These samples were collected as part of a geotechnical investigation, and a subset was analyzed to provide additional site characterization information.

2.6.4.4 Parcel 8 Clinker/Fill Area

Eight soil borings were completed by AME (2005c; 2006e) to approximately 6 to 6.5 feet bgs (DP-8.5 to DP-8.9 and HSA-8.6 to HSA-8.8) within the OU-A portion of the Clinker Piles in Parcel 8. Wood fragments and ash were observed in the borings. At least one clinker and one soil sample were collected at each location and analyzed for metals and SVOCs. Two samples were analyzed for dioxins/furans.

2.6.5 2006 Archaeological Test Pits

GANDA conducted test pit activities in the summer and fall of 2006 in support of upcoming debris removal and geophysical anomaly excavations (see Section 4); its work included test pits at all of the Glass Beach Areas, as shown on Figure 2-3. GANDA specifically looked for prehistoric and historic cultural resources and documented its findings. At Glass Beach 1, the depth of "fill" material ranged from 0 to 40 centimeters (cm; 0 to 16 inches). "Fill" in the archaeological test pits refers to non-native or reworked soils. Soils below the fill contain intact and undisturbed cultural resources (artifacts). At Glass Beach 2, the depth of fill material also ranged from 0 to 40 cm. Archaeological test pits in Parcel 10 (Figure 2-4) show that the depth of "fill" ranges from 0 to 170 cm (0 to 67 inches, or 5.5 feet). However, the test pits did not cover the entire area. An area west of the Parcel 10 Geophysical Anomaly Area was also test-pitted and showed no fill/non-native material.

2.6.6 Summary of Spring (Surface Water) and Groundwater Data for OU-A

Quarterly groundwater monitoring has been voluntarily performed since 2004, after the completion of the Phase I and II ESAs (TRC, 2004b,c). Surface water monitoring of selected springs/seeps began in 2005 and was expanded in 2006 to include several additional locations. Eleven quarterly monitoring reports (third quarter 2004 through first quarter 2007) have been published since then (TRC, 2004f; 2005; AME, 2005e,f,g; 2006b,c,f; ARCADIS BBL, 2007a,e,g). The second quarter monitoring was completed in March 2007 by ARCADIS BBL and results are reported herein (the monitoring report is in progress). Georgia-Pacific was not previously under any regulatory order to conduct quarterly groundwater monitoring. Regular monitoring is now required under the Order, which became effective on February 21, 2007.

Within OU-A, there are four monitoring wells in Parcel 10 (MW-10.1 to MW-10.4). There are four springs/seeps monitored in Parcel 1 (SP-1.1 to SP-1.4), one in Parcel 8 (SP-8.1), and one in Parcel 10 (SP-10.1).

Groundwater at the site generally flows radially toward Soldier Bay and the Pacific Ocean under a horizontal hydraulic gradient of approximately 0.03 foot per foot. Within OU-A, the groundwater flows westerly toward the Pacific Ocean. Groundwater depths at the OU-A have historically ranged from approximately 5 to 30 feet bgs. Historical quarterly groundwater and surface water analytical data for OU-A are discussed below as OU-A North and OU-A South. The screening values used for comparison purposes are discussed and presented in Appendix A.

Stormwater generated within OU-A itself discharges from the site mainly through sheet flow over the coastal bluffs, as demonstrated by deep erosional features along the bluffs, with the rest infiltrating in the unpaved areas. There is a stormwater system at the site that is monitored as part of compliance with the site's industrial stormwater permit. There are a total of six outfall locations; however, only three are located on OU-A. Two drainages (Drainage D and E) are located on OU-A North and one drainage (Drainage A) is located on OU-A South.

The Comprehensive Monitoring Plan (ARCADIS BBL, 2007f) was approved by DTSC on September 7, 2007 and addresses groundwater, surface water, and stormwater monitoring across the site as required by the Order. Data are discussed further in Section 5.

3. Conceptual Site Model

The conceptual site model (CSM) describes the relationship between chemical sources, migration pathways, exposure routes, and possible exposure pathways for human receptors potentially present in OU-A following development of the proposed Coastal Trail and Parkland Zone and existing ecological receptors. CSMs for other operable units (OUs) will be developed separately. The development of the CSM was based on the information and discussion provided in the following sections, and the CSM is illustrated in Figure 3-1.

3.1 Potential Sources of Chemicals

COIs were initially identified based upon historical activities, visible cues present onsite, and findings during the progression of the investigations. Where historical accounts indicated petroleum products were used in an area, COIs associated with petroleum products such as TPH, PAH, and related organic compounds were identified. Where debris from construction or scrap was identified on the surface or partially buried in locations, COIs such as metals were identified. Where ash or evidence of burning was discovered, COIs such as dioxins/furans and PAHs were identified. The primary sources of site-related COIs in site media at OU-A consist of material storage, equipment usage, and facilities operations or practices that contained and/or had the potential to release hazardous substances. These include operational equipment used to move lumber and logs and material disposal and burn areas.

OU-A North, which consists of a thin strip of land that constitutes the western border of the site, was not used for any specific industrial activities during operation of the mill, but was historically used for log storage. The property immediately to the west (Glass Beaches 1 through 3) was not part of the mill until 1947 and was used as public and private dump. Disposal included household waste, scrap metal, and automobiles. Debris materials were discharged both directly onto the bluff top and face near the ocean and also placed into shallow pits for burning. Prior to 1960, an explosives storage shed near the southern end of Glass Beach 2 was used to store dynamite, blasting caps, fuses, and possibly nitroglycerin. These materials were not actually used onsite, but rather were exclusively employed to break up log jams at offsite locations. A scrap yard at the southern end of OU-A North was used for a few years (starting in 1995) for laydown of mostly metal scrap (this scrap was removed in 2004). As discussed in Section 2, there is little evidence of buried debris in OU-A North.

OU-A South was not historically used for industrial sawmill operations (other than some log storage). Potential sources associated with OU-A South include the former Clinker and Ash/Scrap Piles, a Fill Area that encompasses most of OU-A South (where ash and other debris were historically placed), an airstrip, and an area of disposal at the Blowhole feature to the south.

As the site was used primarily as a redwood sawmill, the use of wood treatment chemicals was limited to two areas for a short period of time; neither area was near or adjacent to the boundary of OU-A. The only other treated wood located onsite is associated with railroad ties, possibly impregnated with chromated copper arsenate or creosote (finished products only, not manufactured onsite) that make up a rail line and spur that extended into the southern portion of Parcel 10 in OU-A. These rail lines have since been removed.

Ambient sources of COIs also exist, including ambient/background sources of metals in soils related to site-specific lithologies. Ambient sources of organic chemicals, such as TPH, PAHs, and dioxins/furans are also present. Appendix A includes a discussion of the influences of wood chips and wood materials that can be detected as TPH but are actually natural hydrocarbon materials. PAHs and TPH can also be present due to automobile exhaust and other general urban sources. Similarly, dioxins/furans are ubiquitous in environmental media, due to both natural and anthropogenic sources, such as open burning, forest fires, wood and coal combustion, among other sources.

3.2 Chemicals of Interest

The primary class of chemical constituents used across the site was petroleum. Onsite tanks and drums stored diesel, motor oil, fuel oil, lube oil, hydraulic oil, and diala oil (a petroleum-based electrical insulating oil). These tanks were stored exclusively in areas of the site east of OU-A. Jet fuel was also used for a short time to refuel planes on the runway in Parcel 8, outside the boundary of OU-A. Gasoline was only associated with the former onsite service station (now offsite). Other chemicals used onsite included antifreeze and transmission fluids for vehicle servicing, water treatment chemicals, and small quantities of acids/bases, solvents, paint, and paint thinners. Once again, these chemicals were used in the active industrial portions of the site, which are not within the boundary of OU-A. Transformers were also located within several buildings and on several power poles around the facility; none were located within the boundary of OU-A. Scrap metals, ash/clinker, and burn debris were also found in isolated areas of OU-A. However, metal debris larger than 100 microns is not characterized as a hazardous waste/substance under the Comprehensive Environmental Response,

Compensation, and Liability Act (CERCLA) or the California Health and Safety Code, Section 25316, although soils with elevated metals in the vicinity of debris could be considered hazardous substances. There is no known historical use of pesticides or herbicides onsite, with the exception of the plant nursery area, which is not within or near the boundary of OU-A.

On the basis of the discussion above, the COIs in site media potentially associated with the sources described above are metals, PAHs, TPH, and dioxins/furans (ash/burn debris only). Because of anecdotal accounts reporting the disposal of transformers, PCBs are included as COIs for OU-A North. Site media were also analyzed for additional parameters, such as VOCs, based on DTSC input and for completeness.

3.3 Fate and Transport Mechanisms

In OU-A, the primary potential migration pathways are direct releases to surface and subsurface soil, leaching to groundwater, surface water runoff, groundwater to surface water (seeps), and wind blown transport. Some portions of OU-A along the shoreline in the Glass Beach and Former Scrap Yard areas and Parcels 8 and 10 have exposed soil. Any impacted surface soils in these areas could have potential migration pathways through wind blown transport, surface water runoff, erosion, and leaching to the subsurface soil and groundwater. Subsurface soil in OU-A North is not expected to be significantly impacted because there is little evidence of buried debris and the COIs for OU-A North tend to bind to soil particles and are not conducive to leaching. Subsurface soil in OU-A South may be more significant than OU-A North because of the presence of buried debris. The COIs for OU-A South are similar to OU-A North and are not conducive to leaching. Groundwater in this OU has a potential migration pathway to surface water through seeps in the bluffs.

In the areas in OU-A that are paved (or were paved for significant periods of time historically), contamination of surface soils via direct releases and infiltration is not expected to be significant.

Due to the presence of erosional features along OU-A, exposed soils directly along the shoreline are a potential source of contamination to offshore sediment. Such pathways are discussed in Section 5.

3.4 Receptors

The human and ecological receptors likely to be present at OU-A in the future, following development as trails and parklands, are described in the following sections.

3.4.1 Human Receptors

The primary human receptors likely to be present at OU-A following development are recreational visitors to the trails and parklands (e.g., recreators). There are no plans for residential or commercial/industrial development in OU-A. However, limited construction activities are anticipated during park and trail development as well as ongoing maintenance activities. Therefore, a construction worker and utility/trench worker were also selected as potential receptors in OU-A. In summary, the human receptors that will be evaluated in OU-A are adult and child recreators, construction workers, and utility/trench workers.

3.4.2 Ecological Receptors

Terrestrial plants and wildlife are the primary ecological receptors of interest in OU-A following development of the property as trails and parklands. Although ponds are present on other portions of the site (e.g., other OUs), none are currently present within OU-A. There are groundwater seeps present in or adjacent to OU-A; however, these seeps are not viable habitat for aquatic receptors. Groundwater associated with these seeps will be evaluated at the source (i.e., OU-C through OU-E); although a screening-level evaluation of groundwater and surface water data for OU-A is presented herein. Therefore, the ecological receptors to be evaluated in OU-A are terrestrial plants, mammals, and birds. Specific receptors groups (based on feeding strategy) and representative receptors of interest are discussed in Section 6.

3.5 Exposure Pathway Analysis

Complete and potentially significant exposure pathways for the selected human and ecological receptors are discussed in this section. An exposure pathway is a mechanism by which receptors may come into contact with site-related chemicals. The USEPA (1989) describes a complete exposure pathway in terms of four components:

- A source and mechanism of chemical release (e.g., an aboveground storage tank system leak that releases fuel oil)

- A retention or transport medium (e.g., groundwater in the shallow saturated zone)
- A receptor at a point of potential exposure to a contaminated medium (e.g., commercial worker)
- An exposure route at the exposure point (e.g., inhalation exposure).

If any of these four components is not present, then a potential exposure pathway is considered incomplete and is not evaluated further in a risk assessment. If all four components are present, a pathway is considered potentially complete. Some pathways, although potentially complete may be considered insignificant if they are likely to contribute only a small fraction of the total exposure/dose.

3.5.1 Human Exposure Pathways

Adult and child recreators who may visit the trails and parklands (OU-A) may be directly exposed to chemicals in soil through the following exposure pathways:

- Incidental soil ingestion
- Dermal contact with soil
- Inhalation of airborne soil particulates.

Inhalation of volatile compounds in OU-A is not likely a significant exposure pathway because these compounds have not been found at elevated levels in OU-A (see Section 5); additionally, potential exposure to recreators and workers would be expected to be insignificant because of their limited exposure time and frequency. However, at the request of the regulatory agencies, ambient air exposure to VOCs that are selected as COIs will be evaluated quantitatively in the risk assessment. Therefore, potentially complete exposure pathways for recreators are:

- Incidental soil ingestion
- Dermal contact with soil
- Inhalation of soil particulates

- Inhalation of VOCs in ambient air.

Soils encountered by recreators are most likely to be those in the top 6 inches (0 to 0.5 feet bgs); however, because some grading may occur as a result of the trail construction, the top 2 feet of soil are considered relevant exposure media for recreators under the future-use scenario.

Future construction workers and utility/trench workers may be exposed to chemicals in soil through the following exposure pathways:

- Incidental soil ingestion
- Dermal contact with soil
- Inhalation of airborne soil particulates
- Inhalation of airborne VOC vapors.

Soils encountered by construction workers and utility/trench workers include surface soil within 2 feet bgs, as well as subsurface soil to a depth of 10 feet bgs.

3.5.2 Ecological Exposure Pathways

Terrestrial plants and wildlife may be exposed to chemicals by direct exposure to soil, and in the case of wildlife, by consumption of contaminated prey items (e.g., plants, invertebrates, and wildlife). The relevant soil depth for exposure is assumed to be as much as 6 feet bgs, consistent with CalEPA (1998) guidance and based on the presence of burrowing mammals. However, in many areas of the site (including all of OU-A North), bedrock or undisturbed soils are encountered at 16 inches bgs or less. Consistent with CalEPA (1998) guidance, the depth of exposure will be set at the depth of greatest contamination, which is likely to be the top 6 inches (0 to 0.5 foot bgs) in many locations (e.g., where the release was at the surface and bedrock or undisturbed soils are shallow). In other areas (e.g., where there is buried debris), the assumed depth of exposure to soil will extend deeper (up to 6 feet bgs).

There is no known significant expression of groundwater within the boundaries of OU-A with the exception of springs, some of which are expressed within the boundaries of OU-A, but originate further inland and outside the boundaries of OU-A and discharge to areas outside of OU-A. As discussed in the revised *Site-Wide Risk*

Assessment Work Plan (ARCADIS BBL, 2007h), surface water will be evaluated as a drinking water source (and source of exposure to COIs) for wildlife where there are significant surface water resources (i.e., the ponds associated with OU-E). This pathway, however, is represented as “complete, but likely insignificant” as there are a limited number of seeps/springs in OU-A, they are all very small (less than 1 meter in diameter), they infrequently hold any significant amounts of standing water, and most of them occur on bluff edges or on the tops of steep slopes and cliffs where wildlife access is limited and difficult. Birds and mammals may be able to access some of them, but likely do not use them as primary source of water (low and intermittent flow as well as difficult to access areas like vertical cliff faces); there are more readily available sources of water (ponds) where wildlife have been observed. Based on these considerations, it is extremely unlikely that a bird or mammal could obtain a significant proportion of its drinking water needs from this source.

Groundwater will be considered as a media of potential concern for aquatic receptors outside the boundaries of OU-A (e.g., in the Pacific Ocean). Groundwater and spring data are compared to screening levels herein but will be addressed in separate documents for upland and offshore areas. Soil contamination within OU-A that is found to be a potentially significant source to the offshore receptors will be considered in remedial plans for OU-A.

4. Investigation Summary

As described previously, the purpose of the site investigation work conducted between April and August 2007 was to collect additional data needed to prepare this RI Report, which includes risk assessments and evaluation of the nature and extent of contamination. Review of existing data (which included 155 soil samples, 3 groundwater grab samples, and samples from 4 wells and 6 springs that are regularly monitored) identified some areas of OU-A where there were data gaps. In some areas there was a lack of sampling in a particular location or depth. For example, in the areas between the Glass Beaches in OU-A North, there were some areas where samples had not been collected, or where data for surface soil (0 to 0.5 foot bgs) were lacking. Other data gaps consisted of areas where additional chemical analyses were needed in areas that had been previously tested. For example, further characterization of fill areas in OU-A South for dioxins/furans was needed, although data were available for other chemicals in this area.

As described in Section 2, OU-A North includes Glass Beaches 1 and 2 which were used by the public for the disposal of household waste, scrap metal, and automobiles. Waste was both discharged directly into the ocean and placed into pits for burning. Georgia-Pacific used the Glass Beach Areas (primarily Glass Beach 3 and later Glass Beach 2) for disposal of debris as well. The Parcel 3 Former Scrap Yard/Geophysical Anomaly Area is also located in OU-A North. The southwestern portion of Parcel 3 was used as a scrap yard beginning in approximately 1995. Prior to that time, the area was used to store lumber.

The areas included in OU-A South were primarily used for redwood log and lumber storage, which did not involve chemical usage. Rail spurs were present in OU-A South until the 1950s in Parcels 8 and 10. Some areas in OU-A South were used for the placement of fill and disposal of clinkers and debris.

Data quality objectives (DQOs) were defined in the OU-A Site Investigation Work Plan (ARCADIS BBL, 2007i). These DQOs are also listed in the sampling rationale tables (Tables 4-1 through 4-5). Based on these DQOs, the work plan (ARCADIS BBL, 2007i) was developed to outline additional sampling and analysis to be conducted in OU-A North and OU-A South. In response to agency comments, an addendum to the work plan (ARCADIS BBL, 2007j) was developed. Following the addendum, ARCADIS BBL prepared a clarification letter (ARCADIS BBL, 2007k). The OU-A work plan amendment and clarifications were approved, with minor modifications, by the DTSC in its letter dated April 17, 2007 (DTSC, 2007). In addition, step-out sampling was

conducted as needed in locations where concentrations were found to be elevated as defined by the DQOs. Step-out sampling decisions were made in consultation with the agencies.

Between April 16 and August 17, 2007, ARCADIS BBL collected the following samples in OU-A:

- 47 soil samples from 89 test pits
- 101 soil samples from 39 direct push (Geoprobe™) borings
- 175 soil samples from 80 hand auger borings
- 20 terrestrial invertebrate and 20 co-located plant samples.

Samples were analyzed for one or more of the following:

- Title 22 metals by USEPA Methods 6020 and mercury by USEPA Method 7471
- TPH (TPHg, TPHd, and TPHmo) by USEPA Method 8015M with silica gel cleanup for diesel and motor oil
- PAHs by USEPA Method 8270C and/or 8270C-SIM
- VOCs by USEPA Method 8260 (collected by USEPA Method 5035 [Encore Method])
- PCB congeners by USEPA Method 8082
- Dioxins/furans by USEPA Method 8290.

Soil samples were analyzed by laboratories certified by California Department of Health Services, Environmental Laboratory Accreditation Program. The dioxin/furan analyses were performed by Frontier Analytical Laboratory, El Dorado Hills, California. All other analyses were performed by Curtis & Tompkins Ltd., Berkeley, California. Analytical results are discussed in Section 5. Sample collection, handling, and analysis were conducted in accordance with the *Quality Assurance Project Plan* (ARCADIS BBL, 2007b).

Because of the potential presence of cultural resources, excavation of test pits and hand-auguring of borings were monitored by GANDA, as required by the CDP. In compliance with the site-specific CDP (A-1-FTB-05-053-A2), a marine-mammal monitor was also present when test pits in Parcel 10 were excavated.

Figures 4-1 and 4-2 show the sample locations, which are discussed by AOI, in the sections below. As presented in the work plan (ARCADIS BBL, 2007i), in some cases, proposed sampling locations in the work plan were modified according to site conditions, such as impenetrable formations (i.e., bedrock). Also, reaching the bottom of the fill layer required modification of the proposed sampling depth. Test pit and Geoprobe™ boring logs are included in Appendix B. Photographs of selected field activities are shown in Appendix C. Laboratory reports are provided in Appendix D.

4.1 OU-A North

The Glass Beach Areas include Glass Beaches 1, 2, and 3; the areas between the beaches; and the area east of Glass Beach 3 (Figure 4-1). Additional testing for COIs in surface soil in these areas was needed to facilitate assessment of potential exposure of human and ecological receptors to impacts from disposal and open burning activities. The top 6 to 18 inches of soil in this area is fill and was the focus of the sampling in the Glass Beach Areas because of the lack of surface soil samples and dioxin/furan data. The Former Scrap Yard Area also required additional sampling for COIs both in association with and outside of identified geophysical anomalies. Because of the nature of the wastes (principally scrap metal, construction debris, and household waste, and open burning residue within the Glass Beach areas), soil beneath the fill (native soil) is unlikely to be impacted by these activities. Therefore, subsurface soil in the Glass Beach and Former Scrap Yard Areas is not likely to be impacted and previous sampling activities at OU-A provided sufficient data for deeper soils. The paragraphs below and Sections 4.1.1 through 4.1.6 provide more details on the Glass Beach area sampling; Section 4.1.7 provides more details on the Former Scrap Yard sampling.

Based on past practices and review of existing data in these areas, the main COIs within the Glass Beach Areas are metals (associated with scrap/construction debris) and TPH and PAHs (associated with fuel products, possibly as residuals in scrap/debris). Because a limited number of samples were previously collected for PCB analysis and none were surface samples, surface samples were also analyzed for PCBs. Additionally, because there were reports of burning of debris in some areas, surface samples were also analyzed for dioxins/furans. Existing data indicate that

VOCs and SVOCs (other than common lab contaminants) were not detected above screening levels in 49 out of 50 samples. Therefore, SVOC analysis, other than PAHs, was not conducted. In consultation with the agencies, it was agreed that samples with photoionization detector (PID) readings greater than 20 parts per million would also be analyzed for VOCs.

A total of 82 samples were collected from 33 hand-augured locations in Glass Beaches 1, 2, and 3; between the beaches; and east of Glass Beach 3 (Figure 4-1). Sampling locations were spaced at approximately 200-foot intervals along the top of the bluff above the shoreline and in areas of debris. Soil samples were only collected within the fill layer. Samples were typically collected from the ground surface (0 to 0.5 foot bgs) and 1 to 1.5 feet bgs, if fill material extended to that depth. The surface (0 to 0.5 foot bgs) samples from each of the 33 locations were submitted for analysis. On the basis of the results of the surface samples, at least 50 percent of subsurface (greater than 0.5 foot bgs) were also analyzed, as defined in the Work Plan Addendum (ARCADIS BBL, 2007j). The analytical suite for these deeper samples was selected based on the findings for the surface samples. The deeper samples from at least 50 percent of the locations were analyzed for the full analytical suite (i.e., metals, PAHs, TPH, VOCs, PCBs, and dioxins/furans), but some deeper samples were analyzed for dioxins/furans or metals only. Samples collected as step-outs were analyzed for dioxins/furans and/or metals based on the intention of the step-out sample. Table 4-1 summarizes the sampling conducted at the Glass Beach Areas.

Fill material, consisting of sandy gravel and cobbles to about 8 inches in diameter, was encountered at most of the sampling locations generally to a depth of up to 18 inches. The fill overlies sandy native soil or bedrock that is generally fractured, decomposed sandstone.

4.1.1 Glass Beach 1

At Glass Beach 1, sampling was based on the extent of debris encountered. Debris was observed in a limited area and generally included asphalt and concrete blocks, wood, and metal scrap. Seven soil samples were collected by hand-augering at four locations designated OUA-HA-30 to OUA-HA-33. OUA-HA-30 and OUA-HA-31 were in an area of debris removal, and OUA-HA-32 and OUA-HA-33 were placed approximately 200 feet north and 200 feet south, respectively, of the debris removal area to provide spatial coverage.

Surface samples were collected from the four locations. Subsurface samples were collected at 0.5 to 1 foot bgs at OUA-HA-32, and from 1 to 1.5 feet bgs at OUA-HA-030 and OUA-HA-031. No subsurface sample was collected at OUA-HA-033 because the fill was less than 1-foot thick. Except for the subsurface sample from OUA-HA-30, which was analyzed for dioxins/furans only, the samples were analyzed for metals, PAHs, TPHd, TPHmo, dioxins/furans, and PCBs. Two of the samples from OUA-HA-030 and OUA-HA-032 were also analyzed for TPHg and VOCs because of elevated PID readings. Based on results of the initial sampling in the Glass Beach 1 area, no step-out samples were deemed necessary.

4.1.2 Between Glass Beaches 1 and 2

Three hand-auger boring locations were advanced in the area between Glass Beaches 1 and 2 at 200-foot intervals to provide additional data where previous data were not sufficient. The borings are designated OUA-HA-014 through OUA-HA-016.

Soil samples were collected from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs in each boring. All of the samples from the three borings were analyzed for the full suite of analyses (metals, PAHs, TPHd, TPHmo, dioxins/furans, and PCBs) plus TPHg and VOCs; except the subsurface sample from OUA-HA-014, which was only analyzed for dioxins/furans, TPHg, and VOCs.

Based on the dioxins/furans analytical results in OUA-HA-016, one additional step-out location was placed at OUA-HA-070. Samples were collected from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs and analyzed for dioxins/furans. Based on the results from the step-out location, no additional sampling was necessary.

4.1.3 Glass Beach 2

Very little surface debris was noted at Glass Beach 2. The four hand-auger borings were located at approximately 200-foot intervals in an area where surface analytical data gaps were identified. The borings are designated OUA-HA-026 through OUA-HA-029.

Soil samples were collected from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs. The samples were analyzed for metals, PAHs, PCBs, TPHd, TPHmo, and dioxins/furans. In addition, samples from OUA-HA-026 (1 to 1.5 feet bgs), OUA-HA-027 (0 to 0.5 foot bgs), and OUA-HA-028 (0 to 0.5 foot bgs) had elevated PID readings and were also analyzed for TPHg and VOCs.

Because of elevated lead and dioxin/furans concentrations, step-out locations were warranted. Due to the elevated lead concentration at OUA-HA-027, three step-outs, designated OUA-HA-046 through OUA-HA-048, were sampled from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs for metals. Because concentrations were elevated for dioxins/furans at OUA-HA-027 and lead at the step-outs OUA-HA-046 and OUA-HA-048, two additional step-outs, designated OUA-HA-068 and OUA-HA-069, were sampled at 0 to 0.5 foot bgs and 1 to 1.5 feet bgs for dioxins/furans and metals. OUA-HA-071 was placed as a step-out from OUA-HA-026 because of elevated dioxins/furans concentrations; soil samples from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs were collected and analyzed for dioxins/furans. Another step-out, OUA-HA-072, was placed outward from OUA-HA-029 because of elevated dioxins/furans concentrations; soil samples from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs were collected and analyzed for dioxins/furans. Based on the analytical results from the step-out locations, no additional step-outs were necessary.

4.1.4 Between Glass Beaches 2 and 3

Because the area between Glass Beaches 2 and 3 had not been previously sampled, three hand-auger boring locations were placed at approximately 200-foot intervals. These borings are designated OUA-HA-017 through OUA-HA-019.

Soil samples were collected from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs, except at OUA-HA-017, where samples were only collected at the ground surface because of the depth of the shallow bedrock beneath the fill. The samples were analyzed for the full analytical suite. In addition, the three samples from OUA-HA-017 and OUA-HA-018 were analyzed for TPHg and VOCs because of elevated PID readings.

Because elevated concentrations of dioxins/furans were detected at OUA-HA-018, a step-out location, designated OUA-HA-073, was sampled from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs and analyzed for dioxins/furans. Based on analytical results from the step-out location, no additional step-outs were necessary.

4.1.5 Glass Beach 3

Glass Beach 3 was historically used as a debris disposal area. Four hand-auger borings were selected to characterize soil within the disposal areas. These borings were designated OUA-HA-020 through OUA-HA-023 and were placed in areas of visible surface debris.

Soil samples were collected from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs. Both samples from OUA-HA-020 and OUA-HA-021 and the surface samples from OUA-HA-022 and OUA-HA-023 were analyzed for the full analytical suite. The deeper samples from OUA-HA-022 and OUA-HA-023 were analyzed for dioxins/furans. Seven of the samples were also analyzed for TPHg and VOCs because of elevated PID readings.

Although no surface debris was observed along the southern coastal portion of Glass Beach 3, two hand-auger borings (OUA-HA-044 and OUA-HA-045) were placed to provide data for this area. Soil samples from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs were analyzed for the full suite of analyses.

Because elevated dioxins/furan concentrations were detected at OUA-HA-022, two hand-auger borings, OUA-HA-074 and OUA-HA-075, were located as step-outs. Samples from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs were analyzed for dioxins/furans. Based on analytical results, no additional step-outs were necessary.

4.1.6 East of Glass Beach 3

The East of Glass Beach 3 Area is a relatively small area between Glass Beach 3 and the Parcel 3 Scrap Yard/Geophysical Anomaly Area. The DTSC requested the addition of two hand-auger borings because of a lack of analytical data in this area. The two borings are designated OUA-HA-024 and OUA-HA-025.

Soil samples, collected from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs, were analyzed for the full suite of analyses, as well as TPHg and VOCs because of elevated PID readings. Based on the analytical data, step-outs were not required.

4.1.7 Parcel 3 Scrap Yard/Geophysical Anomaly Area

During previous investigations in the Parcel 3 Scrap Yard between Soldier Bay and Glass Beach 3, 28 geophysical anomalies were identified. The cause for each anomaly was investigated by excavating a test pit at each location. The locations were identified by extracting location coordinates from previous investigation maps and locating them on the ground using a Global Positioning System.

A backhoe was used to excavate test pits, designated OUA-TP-001 through OUA-TP-028, at each of the anomalies through fill material to native soil. The test pit locations are shown on Figure 4-1 and the sample collection matrix is summarized on Table 4-2. The gravelly fill in this area is thin, ranging from 2 to 10 inches. At each

location, metal debris was encountered. The debris included metal sheets and plates measuring up to 1 foot in diameter, nails, bolts, saw blades, cable, wire, fasteners, banding, cans, and engine parts. Test pit logs detailing the debris found in each pit are included in Appendix B, and photographs of the debris are included in Appendix C. The debris from the test pits, as well as from the ground surface, was gathered and placed in the Truck Loading Shed for offsite disposal.

Soil samples were collected from 7 of the initial 28 test pits. Sampled locations were OUA-TP-002, OUA-TP-008, OUA-TP-016, OUA-TP-018, OUA-TP-019, OUA-TP-025, and OUA-TP-028. The locations were selected to provide lateral coverage of the geophysical anomaly area and to collect the minimum number of samples required by the DQOs. OUA-TP-019 was the only location selected based specifically on visual observations, as this location showed staining and odor (no other locations showed any visual staining or odor). Surface soil samples were collected from each of the locations and subsurface samples to the bottom of the fill (approximately 1 ft) were collected at locations OUA-TP-016, OUA-TP-018, and OUA-TP-019. Deeper samples were not collected in the other test pits because the fill material was thin and did not extend below 6 inches bgs. Samples were analyzed for metals, PAHs, TPHd, TPHmo, and PCBs. One sample from OUA-TP-019 was sampled for TPHg and VOCs because of elevated PID readings and a petroleum-like odor.

Based on analytical results for PCBs, seven step-outs, designated OUA-HA-001 through OUA-HA-007 were placed in the area. Soil samples were collected from 0 to 0.5 foot bgs at each location and analyzed for PCBs.

Additional step-outs were necessary because of the analytical results from the first round of step-outs. Surface samples from nine additional locations, designated OUA-HA-049 through OUA-HA-057, as well as a deeper sample at 1 to 1.5 feet bgs from OUA-HA-006, were collected and analyzed for PCBs. Based on these analytical results, no additional step-outs were necessary.

Eight additional test pits were excavated beyond the area of the anomalies to provide lateral coverage of the trail corridor in Parcel 3. These additional test pits are designated OUA-TP-029 through OUA-TP-036.

Soil samples were collected from the ground surface (0 to 0.5 foot bgs) beneath the pavement and road base at all eight locations. Deeper samples up to 1 foot bgs at the bottom of the fill were collected from two locations, OUA-TP-030 and OUA-TP-035 as the fill extended more than 6-8 inches in these locations. The surface and deeper

samples were analyzed for metals, PAHs, TPHd, TPHmo, and PCBs. No step-out samples were needed in this area based on the analytical results.

Small pieces of metal debris were encountered in only two of the eight shallow excavations (see boring logs in Appendix B). The eastern portion of this area is covered with asphalt and gravelly fill up to 1-foot thick.

4.2 OU-A South

4.2.1 Parcels 6 and 8 Coastline Area

The Parcel 6 Coastline Area is a relatively small area that lies east of and adjacent to the City's Wastewater Treatment Plant. This area was sampled to provide lateral coverage of the trail corridor.

Two borings were drilled using the direct-push method to sample depths up to 10 feet bgs to evaluate whether log pond sediments were present in the Parcel 6 Coastline area. The two proposed sampling locations, OUA-DP-029 and OUA-DP-030, were placed at approximately 200-foot intervals in this area, which was identified as having data gaps. In both borings, soil samples were collected from 0 to 0.5 foot bgs and a depth of approximately 5 to 6 feet bgs. At OUA-DP-029, an additional soil sample was collected at 8 to 9 feet bgs. The samples were analyzed for metals, PAHs, TPHd, and TPHmo (Table 4-3). The surface samples were also analyzed for TPHg and VOCs. In addition, the 5 to 6 feet bgs samples were also analyzed for dioxins/furans to evaluate potential log pond sediments. Based on results of the initial sampling, no step-out samples were necessary.

At OUA-DP-029, fill material, consisting of silty sand, crushed rock, and bark, extended to 10 feet bgs, overlying degraded bedrock. At OUA-DP-030, fill extended to 5.5 feet bgs, overlying bedrock. Evaluation of the soil cores at these two locations indicates that log pond sediments are not present in the borings.

The Parcel 8 Coastline Area is a relatively small area that lies south of and adjacent to the City's Wastewater Treatment Plant. Six sampling locations were placed at approximately 200-foot intervals in this area. The locations were originally planned as hand-auger borings and are therefore labeled as "HA" locations. However, the ground surface was hard due to the presence of surface gravel; therefore, a backhoe was used to collect the soil samples. Soil samples were collected at the ground surface (0 to 0.5 ft) at each location, designated OUA-HA-034 through OUA-HA-039, and

analyzed for metals, PAHs, TPHd, and TPHmo. Samples from four of the six locations were also analyzed for TPHg and VOCs.

At the six Parcel 8 locations, a soil sample was collected at 1 to 1.5 feet bgs, except at OUA-HA-035 where the sample was collected at 2 to 2.5 feet bgs. Based on PID readings, four of the six subsurface samples were analyzed for TPHg and VOCs. Three of the six subsurface samples were analyzed for metals, PAHs, TPHd, and TPHmo.

Fill material, consisting of primarily gravel and crushed rock, averaged 1.5 feet thick. Based on results of the initial sampling, no step-out samples were necessary.

4.2.2 North of Parcel 8 Clinker Area

The North of Parcel 8 Clinker Area is a relatively small area north of the Parcel 8 Clinker/Fill Area and south of the Parcel 8 Coastline Area (Figure 4-2). Four boring locations were added to the proposed sampling plan for this area by DTSC, although there is no record of industrial activities in this location. The locations are designated OUA-DP-031 through OUA-DP-034.

The area is underlain by fill, and samples were collected at the top and bottom of the fill. In four borings, samples were collected at the ground surface (top of fill). In three borings, the samples from the bottom of the fill were collected. In the fourth boring, a sample was collected at 6 to 7 feet bgs in OUA-DP-031 at the bottom of the fill. The samples were analyzed for metals, PAHs, TPHd, and TPHmo. The sample from 4 to 5 feet in OUA-DP-033 was analyzed for dioxins/furans due to the possible presence of ash.

The fill in this area, consisting of sandy soil with minor wood chips, ranged in thickness from 3.5 feet to 7 feet with an average of 4.8 feet. Based on the analytical results, no additional step-outs were necessary.

4.2.3 Parcel 8 Clinker/Fill Area

The Parcel 8 Clinker/Fill Area lies in the western portion of Parcel 8 adjacent to the Parcel 10 Geophysical Anomaly Area (Figure 4-2). A north-south transect of borings was proposed in this former clinker pile area to collect additional analytical data where data gaps were identified and to investigate the nature and thickness of fill material.

The five borings are designated OUA-DP-035 through OUA-DP-039 and the sample collection matrix is summarized in Table 4-4.

Soil samples were collected from 0 to 0.5 foot bgs in all five borings and at a depth of between 2.5 feet bgs and 5 feet bgs. The samples were analyzed for metals, PAHs, TPHd, and TPHmo. Six samples were also analyzed for dioxin/furans due to the discolored soil. In addition, the samples from 0 to 0.5 foot bgs at OUA-DP-036 and OUA-DP-039 and at 4 to 5 feet bgs in OUA-DP-039 were analyzed for TPHg and VOCs because of elevated PID readings.

The thickness of fill in this area ranged from 3.5 to 5.5 feet with an average thickness of 4.9 feet. In this area, the debris in the fill consisted of wood chips and bark. Clinker or ash were not noted in the borings. Based on the analytical results, no additional step-outs were necessary.

4.2.4 Parcel 10 Geophysical Anomaly/Clinker Area

Previous geophysical surveys identified numerous anomalies within the northern portion of Parcel 10. A former clinker pile was located within this area (Figure 4-2). To investigate the potential cause of geophysical anomalies and to characterize soil beneath the former clinker pile, 12 test pits were excavated, designated OUA-TP-066, OUA-TP-068, and OUA-TP-071 through OUA-TP-080. Consistent with the DQOs, soil samples were collected from 5 of these 12 locations. Test pits sampled were OUA-TP-072, OUA-TP-074, OUA-TP-075, OUA-TP-077, and OUA-TP-080. These locations were selected because they provide a cross section of the clinker pile area.

Soil samples were collected at the ground surface (0 to 0.5 ft) and 2 to 2.5 feet bgs or 3 to 3.5 feet bgs from each location. An additional sample was collected at 0.8 to 1.2 feet bgs in OUA-TP-072 because of possible ash in the soil/fill material. The samples were analyzed for metals, PAHs, TPHd, and TPHmo. The surface soil sample in OUA-TP-080 and the soil sample at 0.8 to 1.2 feet bgs in OUA-TP-072 were analyzed for dioxins/furans because of possible presence of ash material.

The thickness of fill in the 12 test pits ranged from 1.3 to approximately 4.2 feet, with an average thickness of 2 feet. The fill consisted of silty sand with wood chips, bark, ceramic, clinkers, ash, metal, plastic, and other kinds of miscellaneous debris (Appendix B).

An additional 41 test pits were excavated in the remaining portion of the Parcel 10 Geophysical Anomaly Area beyond the footprint of the former clinker pile. Only scrap metal was found in the test pits with no evidence of chemical contamination. Consistent with the DQOs, soil samples were collected from 6 of these 41 locations. The sampled test pits are OUA-TP-041, OUA-TP-043, OUA-TP-053, OUA-TP-064, OUA-TP-087, and OUA-TP-089. These test pits were selected as representative of all the test pits in the area and to provide lateral spacing across the area.

Samples were collected from 0 to 0.5 foot bgs in the six sampled test pits, from approximately 1 to 2 feet bgs in four of the six pits, and from 4 to 4.5 feet bgs and 7 to 7.5 feet bgs in OUA-TP-041. In addition to the surface sample, two other depth intervals were sampled in OUA-TP-043 ranging from 2.5 to 5.5 feet bgs and from 3 to 3.5 feet bgs. Depth intervals were selected in consideration of the depth of the fill material, with a minimum of the surface sample and one other depth strata sample submitted for chemical analysis; in test pits where the depth of fill extended substantially beyond 5 feet bgs, both mid-depth and deeper samples were collected. Most of the collected soil samples were analyzed for metals, PAHs, TPHd, and TPHmo. In addition, four samples were analyzed for TPHg and VOCs (0 to 0.5 foot bgs, 3 to 3.5 feet bgs, and 5 to 5.5 feet bgs in OUA-TP-043 and 1 to 1.5 feet bgs in OUA-TP-089). One sample from 1.5 to 2 feet bgs in OUA-TP-053 was analyzed for dioxins/furans because of the possible presence of ash material.

Based on the analytical results of the initial sampling, four hand-auger locations were sampled as step-outs because of elevated metals (most notably arsenic) and dioxin/furans results in the 1 to 1.5 feet bgs sample collected at OUA-TP-089 in the southwestern corner of the Parcel 10 clinker area. These step-out locations are designated OUA-HA-040 through OUA-HA-043. The OUA-HA-040 location was augered adjacent to OUA-TP-089 and sampled at 2 to 2.5 feet bgs to vertically delineate elevated metals concentrations found in the original test pit samples. The other three hand-auger locations were sampled from 0 to 0.5 foot bgs, 1 to 1.5 feet bgs, and 2 to 2.5 feet bgs to horizontally and vertically delineate metals concentrations in the area around OUA-TP-089. Based on the analytical results from these samples, no additional step-outs were deemed necessary.

Each test pit was excavated to a depth up to approximately 10 feet to native soil beneath the base of the fill. The thickness of fill ranged from areas of no fill (e.g., OUA-TP-065 and OUA-TP-088, both near the edge of the bluff) to 7.5 feet at OUA-TP-041 near the center of the area. The average thickness of fill encountered in the 41 test pits is 2.5 feet. The fill is characterized by the presence of debris including

wood chips, bark, and metal fragments such as nails, bolts, sheet metal and plates, pipes, and wires. At most locations, pieces of metal similar to those found in Parcel 3 were observed, which were likely the sources of the geophysical anomalies. A photograph of metal recovered from the test pits is shown in Appendix C.

4.2.5 Parcel 10 Fill Area

The Parcel 10 Fill Area consists of the southern portion of Parcel 10. Twenty borings up to 23 feet deep were located in this area to characterize the nature and thickness of fill material and to provide analyses of soil and, most notably, ash or ash-like material occurring within the fill. The boring locations are designated OUA-DP-001 through OUA-DP-020 (Note: soil matrix and Appendix A tables show OUA-DP-001 and OUA-DP-002 in the Parcel 10 Geophysical Anomaly/Clinker Area AOI as that is where they are physically located; however, they were placed to characterize the Parcel 10 Fill Area and are therefore discussed below).

A total of 59 soil samples collected from the 20 borings were analyzed from the Parcel 10 Fill Area. The depth of sample collection was related to the thickness of the fill (e.g., a sample was collected from the surface, the middle, and the bottom of the fill, when possible). At locations with a thicker fill layer, four samples were collected from a boring location. Soil samples were collected between 0 and 1 foot bgs at each location. At 14 of the 20 locations, a sample was collected from an intermediate depth between 2 to 5 feet bgs. A soil sample was collected at a depth greater than 10 feet in 10 of the 20 borings. The maximum depth of a sample was 17.5 to 19 feet bgs. All but one of the 59 samples were analyzed for metals, PAHs, TPHd, and TPHmo. Because of elevated PID readings, 37 of the 59 samples were analyzed for TPHg and VOCs. Because of the possible presence of ash, 17 samples were analyzed for dioxins/furans.

Based on dioxin/furan analytical results from the initial effort, step-outs were necessary from locations OUA-DP-005 and OUA-DP-006. These hand auger locations are designated OUA-HA-058 through OUA-HA-062. At each location, soil samples were collected from 0 to 0.5 foot bgs, 2 to 2.5 feet bgs, and 4.5 to 5 feet bgs for dioxins/furans analysis.

Step-outs were also required based on dioxin/furan results for OUA-DP-017 and OUA-DP-018. These hand-auger locations are designated OUA-HA-063 through OUA-HA-067. At each location, soil samples were collected from 0 to 0.5 foot bgs, 2.5 to 4 feet bgs, and 4.5 to 5 feet bgs for dioxins/furans analysis.

A third round of step-outs for dioxins/furans analysis was required based on analytical results for OUA-TP-058, OUA-TP-061, OUA-TP-064, and OUA-TP-067. These hand-auger locations are designated OUA-HA-076 through OUA-HA-080. At each location, soil samples were collected from 0 to 0.5 foot bgs, 2 to 3 feet bgs, and 4.5 to 5 feet bgs for dioxins/furans analysis.

The fill ranged in thickness from locations with no fill to 19 feet with an average of 8 feet. Four of the five locations with fill greater than 12 feet thick (OUA-DP-010, OUA-DP-014, OUA-DP-016, and OUA-DP-020) occur near the top of the bluff.

Based on the analytical results from the third round of step-outs, no additional step-outs were deemed necessary.

Cross sections of the Parcel 10 fill area are shown in Figures 4-2a through 4-2d. As shown on Figure 4-2a, cross sections A-A' and B-B' are oriented approximately northwest/southeast and C-C' and D-D' are oriented approximately east/west. Significant layers of bark, ash, and clinkers are shown.

A-A' extends closest to and approximately parallel to the edge of the bluff. It shows a shallow, approximately 4 foot thick layer of fill and sediment overlying bedrock in the northern section followed by an area without fill and then additional fill to the south, averaging approximately 12 feet thick overlying an irregular surface of native marine sediment (Figure 4-2b). B-B' is approximately parallel to A-A' and located approximately 500' to 600' inland (Figure 4-2a). B-B' shows an area with no fill at the northern end and fill averaging approximately 8 to 10 feet thick in the southern portion (Figure 4-2c).

C-C' extends east/west in the northern portion of the fill area. Fill is absent near the bluff but becomes greater than 8 feet thick within 300 feet of the bluff (Figure 4-2d). D-D' extends approximately northeast/southwest in the southern portion of the fill area. Along this line, fill was found to a depth of approximately 15 feet approximately 80 feet from the bluff but averages about 8 feet thick further inland (Figure 4-2d).

4.2.6 Former Railroad Tracks Area

The Former Railroad Tracks Area is a relatively small area within the southern portion of Parcel 10 within the vicinity of historical railroad tracks that were removed more than 50 years ago. The purpose of sampling in this area was to obtain surface analytical data for metals and PAHs that may have resulted from railroad activities. Two hand

auger borings, designated OUA-HA-012 and OUA-HA-013, were placed in the vicinity of railroad tracks the locations of which were based on historical air photos.

Soil samples, collected from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs, were analyzed for metals, dioxins/furans, and PAHs. Based on the analytical results, no step-outs were necessary.

4.2.7 Blowhole Area

The Blowhole is a natural feature near the southern shore of Parcel 10. Three hand auger locations were selected because of the lack of data in this area and the occurrence of debris in near-surface soil. The borings are designated OUA-HA-008 to OUA-HA-010.

In the three borings near the Blowhole, soil samples were collected from 0 to 0.5 foot bgs and 1 to 1.5 feet bgs. The surface samples were analyzed for metals, PAHs, TPHd, TPHmo, dioxins/furans, and PCBs. The subsurface samples were analyzed for metals, PAHs, and PCBs, with the exception of the samples from OUA-HA-008, which was not analyzed based on the results from the surface soil sample from that location. Based on the analytical results, no step-outs were necessary.

4.2.8 Parcel 8 Fill Area

The Parcel 8 Fill Area is a relatively small area in the southern portion of Parcel 8 at the southern perimeter of the site. Because of a lack of data from this area, a transect of three boring locations was placed from northeast to southwest across the area. The borings are designated OUA-DP-021 through OUA-DP-023.

The depth of sample collection depended on the thickness of fill. Surface samples (from 0 to 0.5 foot bgs) and samples from 3 to 6 feet bgs were collected in the three borings. In two of the borings, a third sample was collected from 5 to 8.5 feet bgs. These samples were analyzed for metals, PAHs, TPHd, and TPHmo. In addition, two samples were analyzed for TPHg and VOCs because of elevated PID readings.

The fill in this area ranged in thickness from no fill at the southern end of the transect at OUA-DP-021 to 8.5 feet at the northern end at OUA-DP-023. The fill consisted of soil with debris, including bark and clinkers. Based on the analytical results, no additional step-outs were necessary.

4.2.9 North of Native American Homes

The North of Native American Homes Area lies in the southern portion of Parcel 8 along the site boundary, east of the Parcel 8 Fill Area, and north of several Native American homes. Although there is no known historical mill operations activity in this area, DTSC requested the placement of five boring locations in this area because of a lack of data. These borings are designated OUA-DP-024 through OUA-DP-028. DTSC had requested that these borings be extended to 10 feet bgs; however, because there was no observed fill and because of concerns about cultural resources, the borings were only completed to 3 feet bgs.

In all five borings, soil samples were collected from 0 to 0.5 foot bgs and depths between 2 to 3.5 feet bgs. The samples were analyzed for metals, PAHs, TPHd, and TPHmo. No additional step-outs were necessary based on the analytical results.

4.3 Evaluation of Data Quality Objectives and Deviations

This section restates the DQOs, evaluates whether the objectives were met, and discusses deviations from these objectives.

DQO 1: Previous soil samples were collected for the analysis of metals, SVOCs, VOCs, and TPH as well as select samples for pesticides and PCBs near the top of the bluffs along Glass Beaches 1 through 3. Only a few of these samples were collected at the surface, including in areas that are unpaved. None of the samples collected were analyzed for dioxins/furans. Although there was no evidence of ash in any borings or potholes, because material was burned and disposed of in these areas, dioxin/furan data are needed. To fulfill this DQO:

- 80 soil samples were collected and analyzed in the Glass Beach Areas.
- 33 surface soil samples were collected and analyzed.
- 57 samples were analyzed for dioxins/furans.
- 36 samples were analyzed for PCBs.

DQO 2: An investigation of geophysical anomalies detected in the southwestern portion of Parcel 3 was previously proposed. Data are needed to further assess this area. To fulfill this DQO:

- A test pit was excavated at each of the geophysical anomalies in the Scrap Yard area of Parcel 3. Scrap metal was found at each location. Debris that could be a source of additional contamination, such as transformers or paint cans, was not found.
- 30 samples were collected and analyzed in Parcel 3.

DQO 3: Metals and possibly dioxins/furans are COIs in the Clinker/Ash Scrap Area. Some samples have been taken in this area, but no surface soil was sampled. Additional data are needed to assess the nature and extent of COIs in this area. To fulfill this DQO:

- Ten surface samples were analyzed in the Parcel 8 and 10 Clinker/Ash Scrap areas. In addition, 12 test pits were excavated in the Parcel 10 Clinker Area.

DQO 4: An investigation of geophysical anomalies detected in the northern portion of Parcel 10 was previously proposed. Data are needed to further assess this area. Additionally, samples need to be collected in areas where previous boring and test pits showed the presence of ash to test for dioxins/furans (south of the Geophysical Anomaly Area in the Former Fill Area). Both surface and subsurface samples are needed. To fulfill this DQO:

- A total of 52 test pits were excavated to investigate the source of the geophysical anomalies in Parcel 10, and 26 samples were collected and analyzed.
- South of the geophysical area, 20 direct-push borings and 15 hand-auger borings were sampled, and 103 surface and subsurface samples were analyzed. Of these samples, 54 were analyzed for dioxins/furans.

DQO 5: No data have been collected to assess the Blowhole area where surface disposal of debris occurred. Data are needed to assess this area. To fulfill this DQO:

- Three borings were sampled in the vicinity of the Blowhole area and six samples were analyzed for the full suite of analyses.

DQO for All Areas: There has been a concern that elevated levels of chemicals in soils are a source of contamination to offshore sediments. Data are needed for near-shore erodible soils to assess this transport pathway. To fulfill this DQO:

- Soil borings were drilled and sampled at the edge of the bluff to facilitate the assessment of elevated levels of chemicals in soils within this area.

5. Nature and Extent of Contamination

This section summarizes the nature and extent of contamination within OU-A based upon data collected to date (historical and new). Data were evaluated against site background metal concentrations (Table 5-1) and screening levels for soil and surface water (Tables 5-2 and 5-3). Sample matrices for soil, groundwater, and surface water are provided (Tables 5-4 through 5-6) and are color-coded to indicate exceedances of the screening levels. Debris, ash, and archaeological findings in test pits are provided in Tables 5-7 through 5-9. Data from boring logs, pothole logs, and field notes, which also present lithologic information that support this section, are presented in Appendix B.

5.1 Data Evaluation Approach

This section describes the screening levels used to evaluate the nature and extent of chemicals found in soil and water as well as some assumptions about remedial actions. Further evaluation of chemicals found in site media is provided in the risk evaluation in Section 6, which provides a site-specific assessment for relevant human and ecological receptors. The screening levels described and used in Section 5 are generic (not site-specific) and exceedance of these screening levels does not necessarily indicate a potential for risk. Because the screening levels are human health-based, chemicals below screening levels could pose a risk to ecological receptors, which are evaluated further in Sections 6.

5.1.1 Background Levels for Inorganic Chemicals

In accordance with both federal (USEPA, 2002c) and state (DTSC, 1997) guidance, the occurrence of chemicals at ambient and background concentrations may be considered in evaluating the results of investigations for a site. Under DTSC guidance, inorganic chemicals present at or below background levels at a given site are not considered of concern.

Lithology-specific background concentrations for metals in soil were established for the site by ARCADIS BBL (2007c) following DTSC guidance and using data from samples collected within the site. These site background concentrations for metals are presented in Table 5-1. A detailed description of the approach is provided in the *Background Metals Report* (ARCADIS BBL, 2007c). The site-specific lead background level for fill lithology soils is currently under discussion. The final agreed-upon value is

expected to be at or above 25 mg/kg. Therefore, for this RI, a value of 25 mg/kg has been used as an interim background level.

Concentrations of metals in soil samples were compared to site background concentrations. In cases where background levels are higher than the screening level (California Human Health Screening Level [CHHSL; CalEPA, 2005a] or Preliminary Remediation Goal [PRG; USEPA, 2004a), results were evaluated against their respective background concentrations (e.g., arsenic and cadmium). Metals that did not exceed their site background concentrations are not of concern, even if their concentrations were greater than risk-based screening levels.

5.1.2 Dioxins/Furans

Because dioxins/furans are ubiquitous in the environment, it is important to distinguish site-related compounds from background or ambient sources. Section 6.1.2.2 describes the approach used to evaluate site dioxin/furan congener profiles and identify those that are consistent with ambient conditions as detailed in the *Distribution and Sources of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans* report (ARCADIS BBL, 2007d). Dioxin profiles are provided in Appendix E.

5.1.3 Screening Levels for Soil

For discussion purposes, the soil data were first screened against CHHSLs (CalEPA, 2005a). If no CHHSL was available, data were screened against the USEPA Region IX PRGs for residential exposure (USEPA, 2004a). These screening criteria are provided in Table 5-2. Exceedances of these screening values are shown in the tables in Appendix A. Locations of exceedances for select COIs are shown in Figures 5-1 through 5-13. As stated above, exceedances of screening levels do not necessarily indicate unacceptable risk because the future use of OU-A is recreational and not residential.

No CHHSLs or PRGs are available for TPH. Therefore, TPH data in soil were screened against site-specific, risk-based screening concentrations (RBSCs) developed using a methodology presented by Tetra Tech (2006), but using assumptions presented in the revised *Site-Wide Risk Assessment Work Plan* (ARCADIS BBL, 2007h) that incorporated comments from DTSC. RBSCs are specific to carbon-chain ranges. There are three ranges for TPHg, four ranges for TPHd, and one for TPHmo. Both aliphatic and aromatic RBSCs were developed for each carbon-chain range. These RBSCs and their respective carbon-chain ranges are shown in Table A-2 of Appendix A. Appendix A-2 also includes a description of the

development of these RBSCs. It is acknowledged that the agencies have not yet approved the RBSCs; however, the RBSCs used herein have been developed based on recent discussions with and comments from DTSC. It should be noted that the *Site-Wide Risk Assessment Work Plan* indicates the aromatic-based RBSCs only need to be used where there is not sufficient data for aromatic constituents (benzene, toluene, ethylbenzene, and xylene [BTEX] and PAHs). For OU-A, there is sufficient data for these aromatic constituents; therefore, only exceedances of aliphatic RBSCs are of any consequence. Additionally, as discussed in the attachment to Appendix A, a site-specific study was conducted to evaluate the influence of natural organic material (NOM), in the form of wood bark and ash, on "TPH" detected onsite. NOM can interfere with the identification of true petroleum-based hydrocarbons in the motor oil range. It was found that NOM could account for up to 1,000 milligrams per kilogram (mg/kg) of results reported as TPHmo. However, it should be noted that not all of the samples that contained elevated TPH concentrations had elevated NOM.

Because CHHSLs and PRGs are only available for total PCBs and not for Aroclors[®] or individual PCB congeners, the sample data were used to calculate total PCB concentrations, which were then compared against the total PCB CHHSL of 0.089 mg/kg. If only Aroclors[®] were reported, the concentrations of detected Aroclors[®] were summed to obtain the total PCB concentration. The list of PCB congeners analyzed in samples at this site is composed of the NOAA National Status and Trends list of 18 congeners plus the 10 coplanar congeners that were not included in the NOAA list (two were). The original 18 congeners were selected by NOAA to be representative of the chlorination levels of the 209 possible congeners (two from each homolog group), emphasizing those that are typically detected in the environment. The additional 10 coplanar congeners in the list analyzed in site samples do not add much to the total, as they are not abundant in the environment. Through testing, NOAA developed an algorithm to express the relationship of the sum of the 18 congeners to the sum of Aroclors. The algorithm generally returned a factor of about 2.3. Therefore, as discussed with the agencies, for simplicity for the congener analysis the concentrations of detected congeners (of 28 measured) were summed and multiplied by 2 to obtain a total PCB concentration (NOAA, 2000).

Carcinogenic PAHs were evaluated by calculating benzo(a)pyrene (B[a]P) TEQs and comparing the TEQ to the CHHSL for B(a)P. Similarly, dioxins/furans were evaluated by calculating 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) TEQs and comparing to the CHHSL for 2,3,7,8-TCDD.

5.1.4 Screening Levels for Groundwater and Surface Water

For discussion purposes, the groundwater results were evaluated preferentially against Maximum Contaminant Levels (MCLs; USEPA, 2004b) and Public Health Goals (PHGs; OEHHA, 2006). For chemicals that have both MCLs and PHGs, the discussion includes a comparison to both values. For chemicals without MCLs or PHGs, results are screened against PRGs for tap water (USEPA, 2004a). No screening levels are available for TPH in groundwater. Therefore, results are discussed in terms of detected concentrations of the various hydrocarbon mixtures. These screening criteria are provided in Table 5-3. For groundwater, exceedances of screening values are presented in Tables A-7 through A-12 in Appendix A,.

For surface water, the exceedances of the listed screening values are presented in Tables A-13 through A-17 in Appendix A. For surface water, the *California Ocean Plan, Water Quality Control Plan, Ocean Waters of California* (Ocean Plan; CalEPA, 2005b) values, which are numerical water-quality objectives for marine waters of California, were used as primary screening values. For analytes for which an Ocean Plan objective is not available, an effort was made to find a suitable alternative using the water quality limits presented in "A Compilation of Water Quality Goals" from the Central Valley Regional Water Quality Control Board (RWQCB, 2007). The applied screening values are presented in Table 5-3. For Ocean Plan values, separate numerical objectives have been established for the protection of human health and for aquatic life. Objectives to protect human health assume exposure through ingestion of fish that lived in water containing the constituent of concern. The more conservative of the human health and marine aquatic based Ocean Plan values are used in this nature and extent section to screen springs that discharge to the ocean; however, Section 6.3 includes a separate ecological risk evaluation. It should be noted that the Ocean Plan values are used herein without applying a dilution factor; a dilution factor is generally applied to Ocean Plan values to acknowledge the effect of dilution of flows in the high energy offshore environment. The City, for example, discharges an annual average of approximately 0.5 millions of gallons per day (mgd) and a peak wet weather discharge of approximately 5 mgd of wastewater effluent and receives a 50-fold dilution credit.

5.1.5 Presumptive Remedy Areas

Data collected from OU-A underwent a preliminary evaluation, and it was determined that presumptive remedies are warranted in select areas of OU-A. A presumptive remedy area (PRA) is defined herein as an area that likely poses an unacceptable risk or exhibits other criteria that would require remedial action regardless of the

results of any risk evaluations. The PRAs will be subject to further refinement in forthcoming remedial planning documents. Five PRAs were identified for OU-A through an initial data evaluation and any one of the following criteria:

- Presence of metals above the California Hazardous Waste threshold (California Code of Regulations Title 22 Social Security, Division Health Standards for the Management of Hazardous Waste, Chapter 11)
- Presence of PCBs above the action level for PCBs (under the performance-based approach) from the Toxic Substances Control Act (TSCA) (40 Code of Federal Regulations 761.3)
- Presence of “significant” hot spots – areas where two or more adjacent sample locations had concentrations that were 10 times or more the residential CHHSL. The 10 times “criterion” was chosen as a qualitative value used to develop the initial PRAs.

PRAs identified in the individual AOIs are discussed below in the appropriate sections. The establishment of PRAs for soils that meet the above criteria indicates that these areas will be addressed through remediation (both lateral and vertical extent). As such, the data from soil within the PRA will not be included in the risk assessment (Section 6) for OU-A. The outcome of the risk assessment will determine if any additional areas require consideration for remediation.

5.2 OU-A North Soil

The sections below discuss the nature and extent of contamination within AOIs in OU-A North. Exceedances of screening values are noted for soil in Table 5-4. Debris, ash, and archaeological findings in test pits are provided in Tables 5-7 through 5-9.

5.2.1 Glass Beach 1

Soil samples collected from the 12 sample locations throughout Glass Beach 1 were historically sampled for metals, TPH, and VOCs, and more recently sampled for metals, TPH, PAHs, PCBs, VOCs, and dioxins/furans. In general, soil samples in Glass Beach 1 were collected at the surface (0 to 0.5 foot bgs) and shallow subsurface (1 to 1.5 feet bgs). The deepest sample at Glass Beach 1 was collected at a depth of 11.5 feet bgs. The recent sampling focused on the fill layer, which extends from only 0.5 to less than 2 feet bgs. The focus of sample collection in the investigations was

characterization of soils in the vicinity of debris and areas where past practices included the disposal of refuse.

The analytical results from Glass Beach 1 showed exceedances of arsenic and TCDD TEQ concentrations over their respective background and/or screening levels (see Section 5.1). Other chemicals were either not detected or detected below background and/or screening levels.

- Arsenic was detected at four locations at concentrations slightly greater than the background concentration (10 mg/kg). The maximum arsenic concentration was 17 mg/kg (Figure 5-1).
- Dioxins/furans were detected at two locations at TCDD TEQ concentrations that slightly exceeded the CHHSL of 4.6 picograms per gram (pg/g). The TCDD TEQ concentrations at these locations were 5.2 and 12.3 pg/g and are vertically delineated (Figure 5-8). The dioxin/furan profiles (Appendix E) match the ambient profile.

Therefore, although arsenic and dioxins were detected above screening levels, the exceedances are minor (defined as less than or approximately two times the background level or CHHSL).

5.2.2 Between Glass Beaches 1 and 2

As described in Section 4, this area had not been investigated prior to the RI. To fill this data gap, surface (0 to 0.5 foot bgs) and subsurface (1 to 1.5 feet bgs) soil samples were collected from three locations (OU-HA-014 through OU-HA-016) at 200-foot intervals within the AOI. Except for the subsurface sample from OUA-HA-014, the samples were analyzed for metals, PAHs, PCBs, TPH (TPHd, TPHmo, and TPHg), and dioxins/furans. The subsurface sample from OUA-HA-014 was only analyzed for dioxins/furans, TPHg, and VOCs. Based on the dioxin/furan results for OUA-HA-016, additional surface and subsurface samples were collected from a step-out location (OUA-HA-070) and analyzed for dioxins/furans. The sample locations are shown in Figure 4-1.

The analytical results from Between Glass Beaches 1 and 2 showed exceedances of TCDD TEQ concentrations over screening levels. Other chemicals were either not detected or detected below background and/or screening levels.

- TCDD TEQ concentrations in three of the four surface soil samples (locations OUA-HA-015, OUA-HA-016, and step-out OUA-HA-070) and one subsurface soil sample (OUA-HA-016) exceeded the CHHSL (4.6 pg/g) (Figure 5-8). Concentrations in the surface soil ranged from 1.8 pg/g at OUA-HA-014, the northernmost boring, to 36.3 pg/g at OUA-HA-016, the southernmost boring. Concentrations in the subsurface soil were lower, with only the sample from OUA-HA-016 (14.9 pg/g) exceeding the CHHSL. The dioxins/furans results indicate spatial heterogeneity in the dioxin concentrations, with the vertical extent limited largely to the surface (Figure 5-8). The dioxin/furan profiles (Appendix E) match the ambient profile.

The collected data sufficiently capture the horizontal and vertical extent of the dioxins/furans concentrations within the Between Glass Beaches 1 and 2 AOI.

5.2.3 Glass Beach 2

Investigation of this area included the analysis of soil samples for metals, PAHs, VOCs and TPH (TPHg, TPHd, and/or TPHmo), and dioxins/furans. Some historical samples were also analyzed for SVOCs and pesticides. Soil samples have been collected from 18 locations throughout the Glass Beach 2 AOI, generally from the surface (0 to 0.5 foot bgs) and shallow subsurface (1 to 1.5 feet bgs); however, historical samples were collected at depths as great as 6.5 feet bgs (Figure 4-1).

The analytical results from Glass Beach 2 showed exceedances of arsenic, lead, TCDD TEQs, arsenic, and B(a)P TEQs over their respective background and/or screening levels. Other chemicals were either not detected or detected below background and/or screening levels.

- Arsenic was detected in one sample (OUA-HA-48 at 1 to 1.5 feet bgs; 13 mg/kg), slightly exceeding the site background concentration (10 mg/kg; Figure 5-1).
- Lead concentrations were elevated in one area along the bluff where debris was identified (Figure 5-3). Concentrations at four of the seven locations in this area and to a depth of 1.5 feet bgs exceeded the PRG and CHHSL (150 mg/kg). Concentrations were not above the screening levels in the two samples collected from deeper strata (2 to 2.5 feet bgs). Lead concentrations ranged up to 790 mg/kg.

- TCDD TEQ concentrations in 11 of 15 samples (7 locations) collected throughout the AOI exceeded the CHHSL (4.6 pg/g) (Figure 5-8). TCDD TEQ concentrations ranged from 0.36 pg/g (OUA-HA-72, 0 to 0.5 foot bgs) to 49.9 pg/g (OUA-HA-29, 0 to 0.5 foot bgs); however, many of these concentrations were less than 2 times the CHHSL. The dioxin/furan profiles (Appendix E) match the ambient profile.
- The B(a)P TEQs (0.13 mg/kg) in the subsurface sample collected at OUA-HA-27 exceeded the CHHSL (0.038 mg/kg; Figure 5-4). This location is in the area of the bluff that had the elevated lead concentrations.

Because of the elevated lead concentrations, a portion of this AOI has been identified as a PRA (Figure 5-3). Soil in this area will be removed to a depth of approximately 2 feet. Soil outside the PRA did not contain lead above screening levels (Figure 5-3).

The area of soil to be removed because of elevated lead concentrations also encompasses the locations at which the arsenic, B(a)P TEQs, and several of the TCDD TEQ exceedances occurred. In addition, although TCDD TEQs, arsenic, and B(a)P TEQs were detected slightly above screening levels, exceedances are minor and/or the extent is defined sufficiently for risk assessment purposes.

5.2.4 Between Glass Beaches 2 and 3

As described in Section 4, this area had not been investigated prior to the RI. To fill this data gap, soil samples were collected from three locations (OU-HA-017 through OU-HA-019) at 200-foot intervals within the AOI and analyzed for metals, PAHs, TPHd, TPHmo, dioxins/furans, and PCBs. Soil samples were collected at the ground surface and from 1 to 1.5 feet bgs, except at OUA-HA-017, which was not sampled except at ground surface because of the presence of shallow bedrock beneath the fill. Based on elevated PID readings, samples collected from OUA-HA-017 and OU-HA-018 were also analyzed for TPHg and VOCs. As a result of the dioxins/furans analytical results for OUA-HA-18, additional surface and subsurface samples were collected from a step-out location (OUA-HA-073) and analyzed for dioxins/furans. Sample locations are shown in Figure 4-1.

The analytical results from Between Glass Beaches 2 and 3 showed exceedances of TCDD TEQs over the screening level. Other chemicals were either not detected or detected below background and/or screening levels.

- TCDD TEQ concentrations at all four sampled locations slightly exceeded the screening level (CHHSL; 4.6 pg/g). Concentrations exceeded the screening level in surface soil (concentrations ranged from 3.8 to 14.4 pg/g) as well as subsurface soil (concentrations ranged from 0.2 to 12.9 pg/g) samples (Figure 5-8). The dioxin/furan profiles for each sample (Appendix E) match the ambient profile.

Therefore, although TCDD TEQ concentrations were detected above screening levels, exceedances are minor (within 3 times the screening level) and/or the extent is defined sufficiently for risk assessment purposes.

5.2.5 Glass Beach 3

Glass Beach 3 was historically used as a debris disposal area. Samples have been analyzed for metals, PAHs, VOCs, and TPH (TPHg, TPHd, and/or TPHmo), and more recently for dioxins/furans. Some historical samples were also analyzed for SVOCs and pesticides. A total of 17 locations within the AOI have been sampled (Figure 4-1). Samples collected as part of the RI were generally from the surface (0 to 0.5 foot bgs) and subsurface (1 to 1.5 feet bgs), but past samples ranged to depths as great as 9.5 feet bgs.

The analytical results from Glass Beach 3 showed exceedances of arsenic, cadmium, and TCDD TEQs over their respective background and/or screening levels. Other chemicals were either not detected or detected below background and/or screening levels.

- Arsenic exceedances were limited to a single sample; sample GTB-1.7 from 0 to 0.5 foot bgs had an arsenic concentration of 18 mg/kg, which is slightly greater than the site background concentration of 10 mg/kg. The subsurface sample collected beneath this surface sample was below the background concentration and samples collected laterally from this location were also below background concentrations (Figure 5-1).
- Cadmium concentrations exceeded background concentrations at three sample locations. The exceedances were slightly over the background concentration of 2.8 mg/kg, with a maximum concentration of 3.2 mg/kg. Two of the samples were collected at the bottom of the fill material, and the third was a surface soil sample (0 to 0.5 foot bgs). The exceedances are minor and limited in extent (Figure 5-2).

- Dioxins/furan data were collected as part of the RI. Exceedances of the screening level were limited to the surface soil along the northern perimeter of the bluff. Five of the eight surface soil samples exceeded the CHHSL for TCDD TEQs (4.6 pg/g) (Figure 5-8). The surface soil TCDD TEQ concentrations ranged from 0.0747 pg/g at OUA-HA-47 to 52 pg/g at OUA-HA-022. Concentrations in the soil samples collected beneath the surface samples were below the screening level of 4.6 pg/g. Concentrations in the surface soil sample from step-out OUA-HA-074 (9.47 pg/g) only slightly exceeded the CHHSL, while concentrations in the surface and subsurface sample collected from step-out OUA-HA-075 were below the screening level. Based on the sampling results, the elevated TCDD TEQ concentrations appear to be characterized both vertically and horizontally. The dioxin/furan profiles (Appendix E) match the ambient profile.

Although arsenic, cadmium, and TCDD TEQs were detected above screening levels, the extent is characterized, exceedances are minor, and/or the data are sufficient for risk assessment purposes.

5.2.6 East of Glass Beach 3

Surface and subsurface soil samples were collected from two locations in this area and analyzed for the full suite of analyses (metals, PAH, VOC, TPHg, TPHd, TPHmo, dioxins/furans, and PCBs).

The analytical results from East of Glass Beach 3 showed slight exceedances for arsenic and TCDD TEQs over the CHHSL. Other chemicals were either not detected or detected below background and/or screening levels.

- Arsenic exceedances were limited to a single sample; sample OUA-HA-024 from 0 to 0.5 foot bgs had an arsenic concentration of 15 mg/kg, which is slightly greater than the site background concentration of 10 mg/kg.
- The TCDD TEQ concentration in the surface soil sample collected from OUA-HA-024 (8.24 pg/g) slightly exceeded the CHHSL (4.6 pg/g). The concentration in the subsurface sample (1.60 pg/g) and concentrations at the second location (OUA-HA-025) were below the CHHSL (Figure 5-8). The dioxin/furan profiles (Appendix E) match the ambient profile.

Although arsenic and dioxins/furans were detected in one surface soil sample at concentrations slightly above background or the CHHSL, respectively, the extent is characterized.

5.2.7 Parcel 3 Scrap Yard/Geophysical Anomaly Area

Historically, soil samples were collected from 39 sample locations throughout the Parcel 3 Scrap Yard/Geophysical Anomaly Area and sampled for metals, VOCs, TPHs, PCBs, PAHs, and occasionally SVOCs. Ash and/or evidence of burning were not found at this location; therefore, dioxins/furans were not considered COIs. Because the fill is less than 0.5 foot thick, soil samples were generally collected from the surface (less than 0.5 ft. bgs). However, soil samples were collected at 2 and 6 feet bgs from three borings completed as part of the 2005/2006 investigation.

The analytical results from Parcel 3 Scrap Yard/Geophysical Anomaly Area showed exceedances of arsenic, cadmium, vanadium, TPHd, TPHmo, PAHs, and PCBs over their respective background and/or screening levels (see Section 5.1). Other chemicals were either not detected or detected below background and/or screening levels.

- The arsenic concentration in the samples collected from OUA-TP-002 at 0 to 0.5 foot bgs (19 mg/kg), OUA-TP-032 at 0 to 0.4 foot bgs (11 mg/kg), and P3-3 at 0 to 0.5 foot bgs (14 mg/kg) slightly exceeded the site background concentration (10 mg/kg) (Figure 5-1).
- The cadmium concentration in a sample collected from location P3-1 at 0 to 0.5 foot bgs in 2003 (5.9 mg/kg) exceeded background (2.8 mg/kg). Cadmium has not been detected above screening levels in the recently collected samples (Figure 5-2).
- The vanadium concentration in the surface samples (0 to 0.4 foot bgs) collected from OUA-TP-031 (99 mg/kg) and OUA-TP-034 (94 mg/kg) slightly exceeded the site background concentration (90 mg/kg).
- PAHs have been detected at concentrations exceeding screening levels at one location; the B(a)P TEQ concentration (0.060 mg/kg) in the sample collected from OUA-TP-002 at 0 to 0.5 foot bgs slightly exceeded the CHHSL (0.038 mg/kg) (Figure 5-4). With the exception of B(a)P TEQ, concentrations of the remaining PAHs did not exceed their screening levels.

- TPH concentrations exceeded the RBSCs at one location. The only exceedances were at sample location OUA-TP-019; the TPHd and TPHmo concentrations in the soil sample collected from 0 to 0.2 foot bgs exceeded the RBSC (Figures 5-5 and 5-6). The deeper sample collected from this location at 0.6 to 0.8 foot bgs did not show elevated concentrations. TPHg was not detected at concentrations exceeding screening levels.
- Elevated PCB concentrations were found in the northern portion of the Parcel 3 Geophysical Anomaly Area. Screening level exceedances were limited to the surface soil (0 to 0.5 foot bgs); concentrations at nine locations were more than 10 times the screening level (CHHSL: 0.089 mg/kg). This area has been identified as a PRA (Figure 5-7). Soil in this area will be removed to a depth of approximately 6 inches. PCB soil concentrations below 0.5 foot bgs and outside the PRA did not exceed screening levels (Figure 5-7).

Although arsenic, cadmium, vanadium, B(a)P TEQs, and TPH were detected above screening levels, the concentrations are minor, and the extent is characterized and defined sufficiently for risk assessment purposes.

5.3 OU-A South Soil

The sections below discuss the nature and extent of contamination within AOIs in OU-A South. Exceedances of screening values are noted for soil in Table 5-4. Debris, ash, and archaeological findings in test pits are provided in Tables 5-7 through 5-9.

5.3.1 Parcels 6 and 8 Coastline

Soil samples were collected from seven locations within the Parcels 6 and 8 Coastline AOI as part of the RI. The log pond at the site used to extend toward the Parcel 6 portion of OU-A; therefore, sampling was necessary to determine if log pond sediments were present in the area to depths greater than 10 feet bgs. Samples were also collected at ground surface (0 to 0.5 foot bgs) and from well below ground surface (greater than 5 feet bgs). In the Parcel 8 area, samples were collected from surface (0 to 0.5 foot bgs) and subsurface (1 to 1.5 feet bgs).

The samples were analyzed for metals, PAHs, TPHd, and TPHmo. Surface samples with high PID readings were also analyzed for TPHg and VOCs. The deeper soil samples collected in Parcel 6 were also analyzed for dioxins and furans to evaluate potential log pond sediments.

The analytical results showed that the chemicals investigated in this area did not exceed background and/or screening levels (Table 5-4).

5.3.2 North of Parcel 8 Clinker Area

The area north of the Parcel 8 clinker pile was investigated for metals, PAHs, TPHd, and TPHmo as part of the RI. Prior analytical data did not exist. At each of the four borings (OUA-DP-031 through OUA-DP-034), soil samples were collected from the top (0 to 0.5 foot bgs) and bottom (2.7 to 7 feet bgs) of the fill layer that was present at this AOI. An additional sample was collected at 3 to 4 feet bgs in boring OUA-DP-031 to investigate potential vertical variation in the fill layer. Because of the possible presence of ash, the sample collected from the bottom of the fill layer at OUA-DP-033 was also analyzed for dioxins/furans. The analytical results showed that the chemicals investigated in this area did not exceed background and/or screening levels (Table 5-4).

5.3.3 Parcel 8 Clinker/Fill Area

Initial investigation of the Parcel 8 Clinker/Fill Area consisted of soil samples collected from eight locations, which were analyzed for metals and SVOCs. Samples were generally collected from deeper soils (2.5 to 3.5 feet bgs and from 5 to 6 feet bgs), with the exception of three surface samples collected in the northern portion of the AOI. Two samples (DP-8.7 at 2 to 2.5 feet bgs and DP-8.9 at 2.5 to 3 feet bgs) were also analyzed for dioxins/furans. As stated in Section 4, additional soil samples were collected from the ground surface and from the bottom of the fill layer (from 2.5 to 5 feet bgs) in 2007 to better investigate the surface soils and the nature and thickness of the fill material. Samples were collected from five locations along a north-south transect and analyzed for metals, PAHs, TPHd, TPHmo, and in some cases dioxins/furans (OUA-DP-035, OUA-DP-037, and OUA-DP-039). Elevated PID readings in the surface soil at OUA-DP-036 and OUA-DP-039 and at 4 to 5 feet bgs in OUA-DP-039 prompted analysis of these samples for TPHg and VOCs. The analytical results showed that the chemicals investigated in this area did not exceed background and/or screening levels (Table 5-4).

5.3.4 Parcel 10 Geophysical Anomaly/Clinker Area

Soil samples have been collected from a total of 27 locations within the Parcel 10 Geophysical Anomaly/Clinker Area. Samples were generally collected from the surface and one or more additional depths up to 10 feet bgs. As part of the RI, surface soil

samples (0 to 0.5 foot bgs) were collected from 13 locations throughout the AOI. Samples were generally analyzed for metals, PAHs, TPHd, and TPHmo. Selected samples were also analyzed for TPHg, VOCs, and dioxins/furans.

The analytical results from Parcel 10 Geophysical Anomaly/Clinker Area showed exceedances of arsenic, vanadium, B(a)P TEQs, and TCDD TEQs at concentrations over their respective background and/or screening levels. Lead was detected above background levels. Other chemicals were either not detected or detected below background and/or screening levels (Table 5-4).

- Subsurface samples from five separate locations were found to contain arsenic at concentrations in excess of background (10 mg/kg) (Figure 5-9). Concentrations above screening levels ranged from 14 mg/kg (DP-10.9 at 9.5 to 10 feet bgs) to 69 mg/kg (OUA-TP-089 at 1 to 1.5 feet bgs). With the exception of the sample collected from OUA-TP-089, these exceedances occurred in samples at or greater than 5 feet bgs. OUA-TP-089 is near the southwest corner of the Parcel 10 geophysical anomaly area. Step-out samples collected both laterally and vertically from OUA-TP-089 contained COIs at concentrations below background levels.
- The sample collected from OUA-TP-089 at 1 to 1.5 feet bgs also contained lead and vanadium at concentrations slightly exceeding background and screening levels for these metals (lead: 170 mg/kg compared to 25 mg/kg [interim background, fill lithology] and 150 mg/kg [CHHSL and residential PRG]; vanadium: 330 mg/kg compared to 90 mg/kg [background, fill lithology] and 530 mg/kg [CHHSL]). Metals were not detected above background and/or screening levels in the other samples. Step-out samples collected both laterally and vertically contained COIs at concentrations below screening levels.
- Two subsurface samples (DP-10.5 and DP-10.7 at 1 to 1.5 feet bgs) and one surface sample (OUA-DP-002 at 0 to 0.5 foot bgs) had B(a)P TEQ concentrations that slightly exceeded the CHHSL of 0.038 mg/kg (Figure 5-10) with concentrations up to 0.135 mg/kg. PAHs were either not detected in remaining samples or were detected at such concentrations that the B(a)P TEQ concentration did not exceed the screening level.
- TCDD TEQ concentrations exceeded the CHHSL (4.6 pg/g) in surface soil samples at two locations (OUA-DP-002 and OUA-TP-089), with concentrations of 41.4 and 16.6 pg/g (Figure 5-13). The subsurface sample at OUA-TP-089 exceeded the screening level, with a concentration of 18.1 pg/g.

Although arsenic, lead, vanadium, B(a)P TEQs, and TCDD TEQs were detected above screening levels, the extent is characterized and defined sufficiently for risk assessment purposes.

5.3.5 Parcel 10 Fill Area

A total of 107 samples were collected from 46 locations throughout the Parcel 10 Fill Area (Figure 4-2). The area has been investigated for metals, PAHs, VOCs, TPHd, TPHg, TPHmo, and dioxins and furans. The results are discussed below.

The analytical results from Parcel 10 Fill Area showed exceedances of arsenic, B(a)P TEQs, and TCDD TEQs over their respective background and/or screening levels. Other chemicals were either not detected or detected below background and/or screening levels (Table 5-4).

- The arsenic concentration in the sample collected from OUA-DP-005 at 7.5 to 8 feet bgs (12 mg/kg) just slightly exceeded the site background concentration (10 mg/kg) (Figure 5-9).
- B(a)P TEQ concentrations at six locations (nine samples) throughout the Parcel 10 Fill Area exceeded the CHHSL (0.038 mg/kg) (Figure 5-10). Exceedances were detected at varying depths within the fill layer; the maximum detected concentration was 0.345 mg/kg (OUA-DP-018 at 4 to 4.5 feet bgs). The elevated concentrations appear to be characterized both laterally and vertically.
- Elevated TCDD TEQ concentrations were found, mainly within three areas in the Parcel 10 Fill Area. Screening levels were exceeded in soil samples up to 5.5 feet bgs; concentrations at nine locations were more than 10 times the screening level (CHHSL: 4.6 pg/kg). Three small areas have been identified as PRAs (Figure 5-13): one in the northern portion of the AOI and two in the southern portion of the AOI. Soil in these areas will be removed to a depth ranging from 2 to 5 feet bgs. TCDD TEQ soil concentrations outside the PRAs either did not exceed or only slightly exceeded the screening level (Figure 5-13).

Although arsenic, B(a)P TEQs, and TCDD TEQs were detected above screening levels, the extent is characterized and defined sufficiently for risk assessment purposes.

5.3.6 Former Railroad Tracks

Surface soil samples (0 to 0.5 foot bgs) collected from two locations (OUA-HA-012 and OUA-HA-013) within the Former Railroad Tracks AOI and the subsurface (1 to 1.5 feet bgs) soil sample from OUA-HA-012 area were analyzed for metals, PAHs, and dioxins/furans. The analytical results showed exceedances of B(a)P TEQ concentrations over the screening level. Other chemicals were either not detected or detected below background and/or screening levels (Table 5-4).

- The B(a)P TEQ concentration in the surface soil sample collected from OUA-HA-012 (0.525 mg/kg) exceeded the CHHSL (0.038 mg/kg) (Figure 5-10). The PAH concentrations in the subsurface (1 to 1.5 feet bgs) sample from this same boring did not exceed the screening level. PAHs were not detected in the sample collected from OUA-HA-013.

Although B(a)P TEQ concentrations were detected above its screening level, but the exceedance appears minor and very limited in extent.

5.3.7 Blowhole

To characterize the nature and extent of soil contamination in the Blowhole area, samples were collected from three locations (OUA-HA-008 through OUA-HA-010) at ground surface and from 1 to 2.5 feet bgs. The surface soil samples were analyzed for metals, PAHs, TPHd, TPHmo, PCBs, and dioxins/furans. Concentrations in surface soil samples did not exceed screening levels. Based on the results for OUA-HA-008, the subsurface soil sample (2 to 2.5 feet bgs) collected at this location was not analyzed. The subsurface soil samples collected at OUA-HA-009 and OUA-HA-010 were analyzed for metals, PAHs, and PCBs. No screening levels were exceeded (Table 5-4).

5.3.8 Parcel 8 Fill Area

Samples have been collected from a total of seven locations within the Parcel 8 Fill Area. Historically, samples were analyzed for metals, TPHd, TPHg, PCBs, and more recently for PAHs, TPHmo and VOCs if elevated PID readings were detected. Because no ash or evidence of open burning was observed during sampling in this area, dioxins/furans were not considered COIs. Samples were collected from the surface (0 to 0.5 foot bgs), as well as from the deeper fill layers (up to 10 feet bgs), with the final sample depth depending on the thickness of the fill layer. The analytical

results showed that the chemicals investigated for this area did not exceed background and/or screening levels (Table 5-4).

5.3.9 North of Native American Homes

As stated in Section 4, the area North of Native American Homes had not been investigated prior to the RI. Although there is no evidence that mill activities were conducted in this area, the area was investigated for metals, PAHs, TPHd, and TPHmo. Soil samples from the ground surface (0 to 0.5 foot bgs) and from depths ranging from 2 to 3.5 feet bgs were collected from five borings driven along a transect through the area. Consistent with the absence of site-related activity in this area, the chemicals investigated in this AOI were either not detected or detected below background and/or screening levels (Table 5-4).

5.4 OU-A Groundwater and Surface Water

The sections below discuss the groundwater and surface water data for OU-A. Exceedances of screening values are noted in Appendix A Tables A-7 through A-17.

5.4.1 Groundwater

Based on the limited historical activities and limited detections of COIs in soil samples from OU-A, monitoring wells present in OU-A are located in Parcel 10 in OU-A South (MW-10.1 through MW-10.4). These wells have been monitored on a quarterly basis and analyzed for dissolved metals, PAHs, PCBs, TPH, VOCs, and SVOCs. Three groundwater grab samples were collected historically from OU-A North. The grab groundwater samples were collected within Glass Beach 1 in March 2003 with only barium detected well below screening levels.

In accordance with the *Comprehensive Monitoring Plan* (ARCADIS BBL, 2007f), monitoring wells MW-10.3 and MW-10.4 have been removed from the network of sampled wells. In addition, monitoring wells MW-10.1 and MW-10.2 are now sampled for only TPH and dissolved metals. Groundwater flow on Parcel 10 is to the southwest toward the Pacific Ocean.

Historically, dissolved arsenic, dissolved beryllium, benzene, and bis(2-ethylhexyl)phthalate (BEHP) have been the only four COIs detected in Parcel 10 groundwater at concentrations in excess of their respective applicable screening levels.

Other chemicals were either not detected or detected below screening levels (Table 5-5).

- Dissolved arsenic concentrations have exceeded the PHG (0.004 microgram per liter [$\mu\text{g/L}$]) in all wells but only slightly exceeded the MCL (10 $\mu\text{g/L}$) on one occasion in monitoring well MW-10.4 (11 $\mu\text{g/L}$).
- Dissolved beryllium was detected in the third quarter 2004 at concentrations of 4.7 $\mu\text{g/L}$ (MW-10.1) and 4.2 $\mu\text{g/L}$ (MW-10.2), concentrations that slightly exceeded both the PHG (1 $\mu\text{g/L}$) and the MCL (4 $\mu\text{g/L}$).
- Benzene was detected once in the third quarter 2004, at 3.3 $\mu\text{g/L}$, slightly above both the PHG and MCL (0.15 and 1 $\mu\text{g/L}$, respectively) in the sample from monitoring well MW-10.2.
- BEHP detections (maximum of 11 $\mu\text{g/L}$) have exceeded the MCL (4 $\mu\text{g/L}$) but have been below the PHG (12 $\mu\text{g/L}$).

During the first quarter 2007 groundwater sampling event, dissolved arsenic was detected in samples collected from all four monitoring wells at concentrations exceeding the PHG (0.004 $\mu\text{g/L}$), but less than the MCL (10 $\mu\text{g/L}$). The maximum detection was 8.1 $\mu\text{g/L}$. No other COIs (VOCs, SVOCs, PAHs, other dissolved metals, TPH, or PCBs) were detected above applicable screening levels in 2007 events to-date.

The exceedances of screening levels discussed above are minor, are not considered to be of significant concern, and unlikely to result in unacceptable risks.

5.4.2 Surface Water

There are six groundwater seep locations in OU-A. Four (SP-1.1 through SP-1.4) are located in Parcel 1, one (SP-10.1) is located in Parcel 10, and one (SP-8.1) is located in Parcel 8. These seeps were sampled in 2006 and 2007. The seep samples have been analyzed for dissolved metals, PAHs, PCBs, TPH, VOCs, SVOCs, and tannins and lignins. The analytical results are presented in Tables A-13 through A-17 in Appendix A.

The samples from the seeps showed exceedances of beryllium, copper, mercury, zinc, phenanthrene, and TPHmo above their respective screening levels. Other chemicals

were either not detected or detected below background and/or screening levels (Table 5-6).

- Water from seeps in Glass Beach 2 and the Parcel 10 Geophysical Anomaly/Clinker Area had concentrations of beryllium that were an order of magnitude above the Ocean Plan Human Health Criteria (OP-HH; CalEPA, 2005b) of 0.033 µg/L.
- Water samples from SP-1.4 (Glass Beach 1), SP-1.1 (Glass Beach 2) and SP-8.1 (Parcel 8 Fill Area) have had copper concentrations slightly greater than the OP-HH (3 µg/L) on one or two occasions.
- Water from the seep in the Parcel 10 Geophysical Anomaly/Clinker Area had concentrations of mercury that were 2 to 3 times the OP-HH (0.04 µg/L) on four occasions.
- Water from the seep in the Glass Beach 1 area (SP-1.4) had a concentration slightly above the Ocean Plan for zinc (20 µg/L) on one occasion.
- Water samples from Spring SP-1.4 in Glass Beach 1 (Parcel 1) had one detectable concentration of fluorene and phenanthrene, each at 0.01 µg/L. These concentrations slightly exceeded the OP-HH of 0.0088 µg/L.
- TPHmo was detected in one seep sample (SP-1.4) from Glass Beach 1 at a concentration of 88 µg/L.

Exceedances of screening levels for these springs are minor and considered insignificant given the high level of dilution in the high energy offshore environment (for example, wastewater discharges are given a 50-fold dilution factor in this area).

5.5 Summary and Key Findings

As discussed in previous sections, shallow soil in OU-A impacted with COIs above screening levels includes:

- Arsenic and cadmium just above background levels in various areas
- Lead primarily in one portion of Glass Beach 2

- B(a)P TEQs with low level exceedances in various areas
- TPH and PCBs in one portion of the former Scrap Yard
- Dioxins/furans primarily in the Parcel 10 Fill Area.

Two areas in OU-A North (Glass Beach 2 and the Parcel 3 Former Scrap Yard) and three areas within OU-A South (all within the Parcel 10 Fill Area) have been identified as PRAs because of elevated concentrations of lead, PCBs, or dioxin/furans. The soil from these areas can be presumed to be remediated as discussed in Sections 5.2.3, 5.2.7, and 5.3.5. As discussed in Section 3, exposed soils along the bluff edge are erosional and could be transported offsite. However, remediation of the PRAs, which will result in removal of soils along the shoreline that have chemical concentrations significantly above background, screening level, or other criteria, is expected to mitigate this potential pathway.

6. Risk Assessments

This section presents the methods used to conduct both the baseline human health risk assessment (BHHRA) and the ecological risk assessment (ERA), as well as the results of these evaluations. Section 6.1 outlines the decision-making processes used to identify appropriate datasets, select constituents of potential concern (COPCs), and calculate exposure point concentrations (EPCs) for use in the OU-A risk evaluations. Section 6.2 presents the BHHRA and Section 6.3 presents the ERA. Uncertainties associated with each step are discussed within these subsections. Appendices F (Evaluation of the Uptake of Dioxins/Furans by Biota), G (Statistical Methods and ProUCL Output Tables), H (Human Health Risk Assessment Dose and Risk Tables), and I (Ecological Risk Assessment Dose and Risk Tables) provide supporting information.

6.1 Data Evaluation for the Baseline Human Health and Ecological Risk Assessments

This section presents the common steps, shared for both the BHHRA and ERA, to prepare the dataset for quantitative risk calculations.

The spatial area over which a human receptor could be exposed to COPCs is defined as an exposure unit (EU). EUs may be established based on proposed or likely future land use, known historical uses, and/or the spatial distribution of COPCs that suggest the degree of homogeneity (hom) or heterogeneity (het) of the chemical distribution. The future land use of OU-A is recreational (as a trail and park), and OU-A currently consists of two geographically separate areas that will eventually be connected, but not for several years. The initial dedication of the trail and establishment of the parkland will result in separate geographical areas and human receptors may exclusively use one or the other. Ecological receptors may also exclusively or preferentially use one area or the other either because of the different habitats in the two areas or because small home ranges for receptors would preclude them from being exposed over the larger area. Based on this information, two EUs, OU-A North and OU-A South, were created as subunits of OU-A and evaluated separately (Figure 1-2).

And as noted previously in Section 5, exceedances of screening levels or other criteria are such that five areas of OU-A (two in OU-A North and three in OU-A South) have been defined as PRAs. Because these areas will be remediated, samples within these areas were removed from the dataset evaluated in the risk assessment. Section 6.1.3 discusses this approach in more detail.

6.1.1 Data Usability

The available data (from prior and ongoing investigations; see Section 5) collected between 2004 and 2007 (by multiple previous investigators) were initially evaluated and grouped according to the needs of the risk assessments. These data were found to be of sufficient quality for use in this assessment, except as described below.

Data collected for OU-A were validated in accordance with the *Quality Assurance Project Plan* (ARCADIS BBL, 2007b); laboratory data qualifiers generally corresponded to the following:

- R – sample result is rejected
- RL – elevated reporting limit
- J – concentration is estimated
- N – identification of chemical is not confirmed and is considered presumptive
- B – for organic chemicals, chemical was also detected in the blank, and for metals, chemical concentration is estimated
- D – secondary dilution was required prior to analysis
- E – concentration exceeds the calibration range of the instrument and represents the maximum possible concentration
- X – estimated maximum possible concentration, in cases where gas chromatography/mass spectroscopy signals eluting within the established retention time have a signal-to-noise ratio in excess of 2.5 but do not meet ion abundance ratio criteria
- U – chemical was not detected at the reporting limit.

The following set of criteria was used to determine sample usability for risk assessment purposes:

- Analytical results from duplicate samples collected from the same sampling location during the same sampling event were considered usable for risk assessment. When a chemical was detected in both the original sample and the duplicate sample, the results were averaged. When one sample result showed no detectable concentration and a duplicate sample showed a detected concentration, only the detected concentration was included in the dataset. If a chemical was not detected in either the original sample or the duplicate sample, the average reporting limit from the two samples was used to estimate the concentration for that sample.
- Elevated reporting limits, qualified with a “U” designation exceeding the maximum detected concentration of a chemical at any level were excluded in the EPC calculations (USEPA, 1989).
- Samples collected outside the spatial bounds of OU-A or soil samples below the maximum depth considered (10 feet bgs) were not used in the risk assessment.
- As stated above, samples located within the PRAs were excluded from the risk assessment (see further discussion in Section 6.1.3).

Furthermore, in some cases, a chemical was reported in the results for multiple analytical methods in the same sample. In an effort to develop a database that reflects site conditions at OU-A, the following selection hierarchy was followed to identify the appropriate result to use in the risk assessment:

- USEPA Method 8270-SIM was selected for the PAH and dibenzofuran results followed by (in order of preference): USEPA Methods 8310 and 8270
- USEPA Method 8260 was selected for the 1, 2, 4-trichlorobenzene and BTEX results
- USEPA Method 6020 was selected for metals (except mercury, which is analyzed by USEPA Method 7471A)
- USEPA Method 8015 was selected for TPHg, TPHd, and TPHmo.

In addition, based on similarity in toxicity, the following chemicals were summed together and evaluated as single constituents:

- PCB congeners and Aroclor mixtures were each summed together to develop a total PCB concentration. In the case of PCB congeners, the sum was multiplied by two to derive total PCBs.
- The detected 2,3,7,8-substituted dioxin/furan congener concentrations were multiplied by their corresponding toxicity equivalency factors (TEFs) and the results summed together to develop a TCDD TEQ concentration.
- The o,m,p-xylene isomer concentrations were summed for total xylenes.
- The carcinogenic PAH concentrations were multiplied by their corresponding TEFs and the results summed together to develop a B(a)P TEQ concentration.

Data quality was evaluated based on the QAPP (ARCADIS BBL, 2007b). Reporting limits for non-detected analytes were reviewed for sufficient sensitivity and reliability. Reporting limits are presented in the data summary tables (Appendix A). Reporting limits exceeding the available screening levels occurred for a single cadmium result and for six PAH analytes in 91 samples. The PAH analytes with elevated reporting limits were: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. The elevated reporting limits identified were deemed insignificant given the large overall dataset and the sensitivity and reliability of the analysis determined to be acceptable.

Once the dataset was defined, the chemicals were then subjected to a COPC selection process. Depth intervals were selected for evaluation for each receptor (see Section 6.1.3) and media-specific (e.g., soil, air, etc.) EPCs were then calculated for each COPC. Sections 6.1.2 through 6.1.4 discuss these steps in detail.

6.1.2 Selection of Constituents of Potential Concern

After the data were evaluated using the steps described above, COPCs were identified. Generally, chemicals are selected as COPCs if they are detected frequently at concentrations exceeding background levels. COPC selection methods varied only slightly for the BHHRA and ERA components.

The following list summarizes the general COPC selection criteria:

- With the exception of known human (Class A) carcinogens, chemicals were eliminated as COPCs if the frequency of detection (FOD) was below 5% according

to USEPA risk assessment guidelines (USEPA, 1989). As a conservative measure, known human carcinogens (Class A) were not subject to this COPC screening criterion. Additionally, this step was not used for the ERA.

- Chemicals typically considered common laboratory contaminants (e.g., acetone, 2-butanone, methylene chloride, and phthalates) were excluded as COPCs, if this classification was supported following review of the analytical laboratory data and information regarding potential COIs for OU-A (USEPA, 1989).

An additional step was used to select COPCs that included evaluation of OU-A data compared to ambient or background levels for metals. Additionally, congener profiles for dioxins/furans were evaluated (although this evaluation was not used to select COPCs). Each of these is described below, and lists of the COPCs are presented in Tables 6-2 and 6-3 for OU-A North and OU-A South, respectively.

6.1.2.1 Background Comparisons for Metals

Metal concentrations were compared against background levels (Table 6-1) to evaluate whether measured concentrations are likely to be site-related. A metal was eliminated as a COPC if the maximum detected concentration was below the upper-bound background concentration (ARCADIS BBL, 2007c). The site-specific lead background level for fill lithology soils is currently under discussion. The final agreed-upon value is expected to be at or above 25 mg/kg. Therefore, for this RI, a value of 25 mg/kg has been used as an interim background level.

6.1.2.2 Evaluation of Dioxins/Furans

Because dioxins/furans are ubiquitous in the environment, it is important to distinguish site-related compounds from background or ambient sources. Detailed methods for identifying the ambient and non-ambient dioxin/furan congener profiles are provided in the *Distribution and Sources of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans* report (ARCADIS BBL, 2007d). It is recognized that this revision has not yet been reviewed or approved by DTSC. Therefore, no elimination of dioxins/furans as COPCs has been recommended for the risk assessment.

A total of 174 soil samples have been collected from OU-A and analyzed for dioxins/furans. Of these, 57 samples were collected from OU-A North and 117 samples were collected from OU-A South. With the exception of one sample (OUA-DP-012), collected from a depth of 10 to 10.5 feet bgs in OU-A South, the samples were from

within the 0- to 10-foot bgs depth interval that is used for the risk assessment. Sample OUA-DP-012 (10 to 10.5 feet bgs) was excluded from the dioxin/furan COPC selection process because it was not collected within the 0- to 10-foot bgs depth interval.

Evaluation of dioxin/furan congener profiles (Appendix E) shows that 96% of the soil samples collected in OU-A North are consistent with the ambient dioxin/furan congener profile for the site. For the two samples (presented in Table 6-1a) with congener profiles that are not consistent with ambient conditions, the TCDD TEQ concentrations were 0.27 and 4.6 pg/g, which are at or below the risk-based level (i.e., CHHSL of 4.6 pg/g).

As discussed in Section 5, three PRAs have been identified in OU-A South where soil associated with 19 soil samples with TCDD TEQ concentrations ranging from 5.7 to 316 pg/g will be removed. A total of 98 soil samples with dioxin/furan results will remain following the implementation of the PRAs with TCDD TEQ concentrations ranging from 0.00040 to 40 pg/g. Of these remaining soil samples, 74% have dioxin/furan congener profiles (Appendix E) that are consistent with the site ambient dioxin/furan congener profile. A relatively high proportion (26%) of samples have congener profiles that are not consistent with the site ambient dioxin/furan congener profile (presented in Table 6-1a).

6.1.3 Vertical and Spatial Data Evaluation

Soil data used to assess potential ecological and human health risks consist of data representative of the environmental media to which a receptor can realistically and significantly be exposed. Specific depth ranges were chosen based on the exposure scenarios for the receptors evaluated. Another criterion for selecting the depth range is the vertical profile of contaminants. In cases where higher concentrations of COPCs were found in shallower soil, the soil depth range was adjusted to eliminate "dilution" of elevated shallow sample results with lower concentrations from deeper samples. The following sections describe the vertical bounds that correspond to general receptor scenarios.

6.1.3.1 Soil

Surface/shallow soil depths can be defined as follows:

- 0 to 0.5 foot bgs: This depth range is pertinent to all human receptors and specific to human receptors not engaged in subsurface activities (e.g., recreators), as well as non-burrowing ecological receptors.
- 0 to 2 feet bgs: Assuming some regrading of shallow soils, this depth range is also relevant to human receptors not engaged in subsurface activities (e.g., recreators).

Subsurface soil depths can be defined as follows:

- 0 to 6 feet bgs: This depth range accounts for potential exposures associated with burrowing ecological receptors.
- 0 to 10 feet bgs: This depth range applies to human receptors who may be engaged in subsurface activities (e.g., utility work) and also accounts for a scenario where grading of the soil during redevelopment activities brings subsurface soil to the surface.

Summary statistics for the soil depths discussed above are presented in Tables 6-4 and 6-5 for OU-A North and OU-A South, respectively. Because EPCs (described in Section 6.1.4 below) for the 0- to 0.5-foot bgs dataset generally contained the highest concentration of chemicals, this interval was used to evaluate all receptor exposure scenarios in OU-A. For some individual constituents, the deeper intervals had slightly higher concentrations; however, overall and for the expected risk-driving constituents (e.g., dioxins/furans) the 0- to 0.5-foot bgs interval had the highest EPCs. For burrowing ecological receptors, both the intervals between 0 to 0.5 foot bgs and 0 to 6 feet bgs were evaluated.

Soil samples with a top or starting sample depth less than the bottom or ending depth of the soil depth interval defined above for the risk assessments were included within the dataset for that interval. For example, a soil sample with a top depth of 0 foot bgs would be included as part of all depth-specific datasets and a sample with a top depth of 0.5, 1, or 1.5 feet bgs would be part of all except the 0- to 0.5-foot bgs dataset. With this approach, a sample that spanned the bottom depth of a particular depth interval, would be included within the dataset for the appropriate depth interval). For example, a sample collected from 5 to 7 feet bgs would be included in both the 0- to 6-foot and 0-to 10-foot bgs intervals.

6.1.3.2 Water

Groundwater and seeps/springs were evaluated in the OU-A Work Plan as a potential source of contamination (ARCADIS BBL, 2007i). However, chemicals detected in these water sources were below agency thresholds of concern (Section 5). As a result, the potential exposure pathway from groundwater to a human receptor is considered incomplete and was not evaluated. However, the pathway for ecological receptors potentially contacting groundwater through seeps/springs was evaluated, and additional information is presented in Section 6.3 of this report.

6.1.4 Exposure Point Concentration Calculation

The EPC is the concentration of a COPC in an environmental medium to which a hypothetical receptor might be exposed. Using USEPA's ProUCL 4 software (<http://www.epa.gov/nerlesd1/tsc/software.htm>), a conservatively based 95% upper confidence limit (95% UCL) on the arithmetic mean concentration was estimated and used to represent the EPC for each COPC (USEPA, 1989; CalEPA, 1992). A more detailed description of the methods used to estimate EPCs for OU-A, including the ProUCL 4 output tables (for all COPCs), is presented in Appendix G. Tables 6-4 and 6-5 present the EPCs for COPCs at OU-A North and OU-A South, respectively.

For dioxins/furans, TCDD TEQs were calculated using TEFs. The dioxin/furan congeners each had their detected concentration multiplied by their respective TEF, which were subsequently summed to produce the TCDD TEQ for each sample. The TCDD TEQs were used to calculate the EPCs. There are mammalian-specific TEFs (Van den Berg et al., 2005) and avian-specific TEFs (Van den Berg et al., 1998), both are used identically in the calculation of TCDD TEQs.

To estimate EPCs, results for those chemicals reported as total concentrations and chemicals sampled within PRAs required the use of proxy values. Proxy values are defined as concentration that were chosen to substitute results for samples that fall within the PRA lateral and vertical boundaries. Proxy values were chosen according to the rationale presented below:

- Samples that were listed as nondetect for total PCBs, B(a)P TEQs, TCDD TEQs, and total xylenes were assigned a proxy value (instead of zero) that was conservatively set equal to the lowest detected concentration of the constituent within an EU.

- For the PRAs, to account for the presence of COPCs in imported fill material that will be used to backfill these areas, actual chemical concentrations in backfill material recently obtained for the site (laboratory reports provided in Appendix G) were used as proxy values for each sample point where these constituents were originally sampled. For organic chemicals, zero values were used for those constituents that were nondetect in imported fill. For inorganic chemicals, proxy values were used to replace the original data within the PRA for each sample that was collected.

6.1.5 Uncertainties Associated with Data Evaluation

The steps associated with the data evaluation process can impact the results of the risk assessment. Each of these steps and how they might impact the results of the risk assessments for OU-A are discussed below.

6.1.5.1 Data Usability

As part of this step, tentatively identified compounds (TICs) and reporting limits exceeding the maximum detected concentration of any corresponding chemical were excluded from both the BHHRA and the ERA datasets. Each of these steps is addressed in more detail below.

Excluding Reporting Limits Exceeding the Maximum Detected Concentration

The exclusion of a chemical reporting limit result that exceeds the maximum detected concentration for that chemical is consistent with agency guidelines (USEPA, 1989). Including these reporting limits in the dataset would artificially raise the EPC and result in an overestimate of impacts at OU-A. A discussion of elevated reporting limits is presented in Section 6.1.1.

Multiple Results for the Same Chemical in the Same Sample

The selection rules, as presented in Section 6.1, used to identify the most appropriate result were heavily based on a review of the sensitivity and reliability of the analytical methods in question. Implementing this approach into the data evaluation portion of the risk assessment resulted in a more accurate dataset.

6.1.5.2 Selection of Constituents of Potential Concern

The COPC identification methods utilized in this assessment are consistent with USEPA (1989) guidelines. The inclusion of known human carcinogens detected in less than 5% of the samples addressed DTSC concerns and may result in an overestimate of cancer risk. Inclusion of chemicals with <5% FOD in the ERA likely overestimates risk. Exclusion of laboratory contaminants leads to a more accurate estimate of site-related impacts (eliminates potential false-positive results).

Screening metals against background levels may impact the risk assessment significantly. If the background levels are inappropriately low, the result will be a higher number of COPCs and potentially higher risk estimates that are actually associated with ambient conditions and not site-related influences. If the background levels are inappropriately high, a lower number of COPCs will be evaluated and result in an underestimate of risks at OU-A. In general, there is a high confidence in the background levels presented by ARCADIS BBL (2007c) as the dataset is robust. However, the overall method for selecting background levels has some subjective elements and was overall geared to be conservative. Additionally, because a 99th percentile value was used to represent the upper-bound concentration of the background population, on average, 1 in 100 samples will be classified as site-related when they are actually within the background population.

6.1.5.3 Vertical and Spatial Evaluation

Sampling at OU-A was conducted extensively across the entire area since 2004. Sampling is assumed sufficient to adequately characterize both the horizontal and vertical extent of (chemical) impacts at OU-A for risk assessment purposes. The collection of additional samples is not likely to impact the results of this assessment.

The OU-A risk evaluation looked at four separate soil depths based on anticipated human and ecological receptor activity. Current human-related exposures were evaluated by conservatively selecting the soil depth interval that contained the higher concentrations of site-related chemicals (i.e., had the highest EPC). The 0- to 0.5-foot bgs interval was selected as generally the highest concentration interval, especially for the risk-driving EPCs. Some COPCs had slightly higher EPCs at depth, but the use of a different depth interval would not have affected the overall risk results and conclusions. The 0- to 6-foot bgs soil depth was also evaluated for burrowing mammals (DTSC, 1996). Only data to 10 feet bgs were assessed to account for future

site-related exposures (construction and the excavation of subsurface soil to the surface), consistent with state agency expectations and guidance (CalEPA, 1992).

Datasets were defined based on the inclusion of samples with a start depth less than the bottom depth of the dataset interval in question. This approach may result in the inclusion of some samples with bottom depths that extend deeper than the dataset depth range. Review of the data, however, indicates that these instances rarely occur and are unlikely to affect the overall EPCs.

Revising the methods listed above to refine and recreate depth-specific datasets is not likely to impact the results of either BHHRA or the ERA significantly.

6.1.5.4 Exposure Point Calculation

For this assessment, UCLs for the arithmetic mean were calculated with ProUCL 4.0 and the statistic used to represent the EPC was selected in accordance with USEPA (2007a,b) guidance (see Appendix G). USEPA's criteria for identifying the optimal UCL are based on numerical experiments with numerous hypothetical datasets. While the criteria are intended to identify the subset of methods that are unlikely to underestimate the 95% UCL, USEPA acknowledges that certain datasets may be difficult to characterize with a specified degree of confidence. These conditions are outlined below, and soil COPC datasets that correspond to these conditions are discussed. Note that soil EPCs were developed for 348 unique datasets as follows:

- 41 COPCs in OU-A North (Table 6-4)
- 46 COPCs in OU-A South (Table 6-5)
- 4 depth intervals per OU-A ($[41 + 46] \times 4 = 348$).

Use of Maximum Detected Concentration for the Exposure Point Concentration

For large sample sizes, the 95% UCL is considered to be sufficiently health protective estimate of the EPC. However, for small sample sizes, the maximum concentration is preferred over the 95% UCL for estimating the EPC. Following USEPA (2007a,b) guidance, the maximum detected concentration was used to represent the EPC when either of two conditions was satisfied: 1) total sample size (n) less than eight; or 2) total number of detects less than five. Each condition addresses different sources of uncertainty and can affect the overall risk estimates in different ways, as discussed

below. For this assessment, the first condition is much less common because the sample sizes are generally very high for all COPCs.

The first condition ($n < 8$) addresses uncertainty due to a lack of coverage of the sampling design. A small sample size may not adequately characterize elevated concentrations within an EU, resulting in a 95% UCL that underestimates the desired UCL for the mean. Although USEPA (2007a,b) cautions that it is highly unlikely that a receptor will be exposed to the maximum concentration over the entire exposure duration, it is assumed that the maximum concentration for small sample sizes is unlikely to represent the true maximum concentration within the EU and that it yields a more reasonable estimate of the long-term average concentration than a UCL. For this assessment, approximately 1% (4 of 348) of the EPCs are based on the maximum detected concentration (i.e., at least one detect) in order to offset the uncertainty due to a small sample size ($n < 8$). In OU-A North, EPCs for toluene in 0 to 0.5 foot bgs and 0 to 2 feet bgs are based on the maximum detected concentration (sample sizes of 5 and 6, respectively). In OU-A South, EPCs for benzene in 0 to 2 feet bgs and total PCBs in 0 to 0.5 foot bgs are based on the maximum detect, with sample sizes of 6 and 5, respectively. The impact of the use of the maximum detected concentration is unclear for these EPCs.

The second condition (number of detects < 5) addresses uncertainty due to limitations in statistical methods for left-censored data. It is difficult to determine a UCL for left-censored datasets with fewer than five detects, even when the total sample size is relatively large (e.g., $n > 30$). Goodness-of-fit tests, which are used to identify the set of UCL methods that perform well for specific distributions, are unreliable for highly censored data. Furthermore, UCLs based on bootstrap resampling techniques generally require more than four unique samples to generate a reliable confidence interval (USEPA, 2007b). Because the UCL cannot be calculated, the maximum detected concentration is used to represent the EPC. However, this may greatly overestimate the long-term average concentrations for cases in which the maximum concentration represents a very small subset of the EU and the majority of the exposures are likely to occur with soils that have much lower concentrations (i.e., less than reporting limits). For this assessment, approximately 9% (31 of 348) of the EPCs are based on the maximum detected concentration because the dataset contains between one and four detects (despite a total sample size greater than or equal to eight). The following seven COPCs comprise these datasets in OU-A North: acenaphthylene, anthracene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, TPHg C6-C8 and C8-10, and p-isopropyltoluene. The following eight COPCs comprise these datasets in OU-A South: 2-hexanone, benzene, bromomethane, chloroform,

chloromethane, TPHg C6-C8, toluene, and total PCBs. In these cases, use of the maximum concentration is likely to overestimate long-term average exposures.

Multiple Upper Confidence Limit Methods

Calculations performed with ProUCL 4.0 will sometimes result in multiple recommended UCLs. USEPA (2007a,b) does not provide specific guidance on how to determine if one method is preferred, instead allowing flexibility to consider site-specific data on a case-by-case basis. If the relative percent difference (RPD) was less than 5%, it was assumed in this assessment that the results are comparable and the higher of the two values was selected to represent the EPC. This procedure may yield up to a 5% overestimate in the EPC. For this assessment, EPCs for approximately 16% (55 of 348) of the EPCs evaluated in both OU-A North and OU-A South matched these conditions.

If RPD was greater than 5%, the UCL methods were evaluated on a case-by-case basis. For this assessment, approximately 2% (8 of 348) of the datasets evaluated matched these conditions, with RPDs ranging from 11 to 72% (p-isopropyltoluene in OU-A South, 0 to 6 feet bgs). The following four COPCs comprise these eight cases: benzene, benzo(k)fluoranthene, TPHg C8-C10, and p-isopropyltoluene. In each case, two methods were recommended as equally plausible (KM[t] or KM [percentile bootstrap]) and the number of detects is either six or seven. Because the bootstrap methods can sometimes yield unreliable results for datasets with such a low number of detects (USEPA, 2007a,b), the KM(t) UCL was selected to represent the EPC in each case. Given the relatively small number of cases and the narrow range of RPDs, this source of uncertainty is unlikely to have an impact on the results of the risk assessment.

Optimal Upper Confidence Limit Exceeds Maximum Detected Concentration

Sometimes the UCL value calculated by ProUCL 4.0 for the optimal UCL method will exceed the maximum detected concentration. For this assessment, there were no cases of this source of uncertainty for datasets with adequate sample sizes to support a UCL calculation.

Frequency of Detect Less than 30 Percent

The decision rules developed by USEPA for identifying the optimal 95% UCL method reflect a systematic evaluation of the coverage of each method for a broad range of

datasets (USEPA, 2007). USEPA did not test the performance of the UCL methods for datasets with less than 30% FOD and cautions that the UCL estimates may be unreliable for more highly censored datasets (USEPA, 2007a,b). For this assessment, a 95% UCL is used if the total sample size is at least eight, with at least five detects. Therefore, FOD is greater than or equal to 30% for total sample sizes in the interval 8 to 15 (i.e., 5 detects among 15 total observations = 30% FOD). For this assessment, approximately 17% (60 of 348) of the datasets have at least 15 total observations and less than 30% FOD. The total sample size for these datasets ranges from 28 to 193 and the minimum FOD is 8%. The following nine COPCs comprise these datasets in OU-A North: benzo(a)anthracene, B(a)P, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, diesel C10-C12, indeno(1,2,3 cd)pyrene, and naphthalene. The following 12 COPCs comprise these datasets in OU-A South: acenaphthene, acenaphthylene, anthracene, B(a)P, benzo(g,h,i)perylene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, fluorine, TPHg C6-C8 and C8-C10, indeno(1,2,3 cd)pyrene, and p-isopropyltoluene.

Proxy values were assigned to groups of chemicals under the following conditions:

- PRAs: To account for levels of chemicals in imported fill material, actual data for fill soils were used in place of samples within the PRAs. This approach is appropriate if the fill material accurately reflects post-remediation conditions. The fill material used is likely representative. Additionally, a “sensitivity” analysis was performed for lead and dioxins/furans to assess whether the effect of using alternate values (i.e., background levels for metals, nondetect or zero values), and the overall approach used herein was conservative, but not overly conservative (EPCs were within 10% of one another).
- Total PCBs, TCDD TEQs, B(a)P TEQs, and total xylenes: Any of these COPCs reported as a nondetect was assigned a proxy value equivalent to the lowest detected concentration for that chemical within a specific EU. This represents a conservative approach and may result in an overestimate of impacts.

6.2 Baseline Human Health Risk Assessment Approach

This section presents the methods and the results of the BHHRA conducted for the two EUs evaluated within OU-A: OU-A North and OU-A South. The purpose of the BHHRA is to assess exposure and evaluate potential risks and hazards to hypothetical human receptors that may be present in OU-A. The BHHRA is based on both federal and

State of California risk assessment guidance (and on direct input from DTSC), as outlined in the *Site-Wide Risk Assessment Work Plan* (ARCADIS BBL, 2007h).

6.2.1 Purpose and Objectives

The purpose of the BHHRA is to evaluate potential risks to human health associated with exposure to site-related constituents (i.e., COPCs) in onsite environmental media. Risk management decisions protective of human health will be made, as needed, based on the results of the BHHRA to facilitate the remediation decision-making process. Ultimately, the conclusions reached in the BHHRA, along with information from the ERA (Section 6.3), will provide a comprehensive risk management strategy for OU-A.

6.2.2 Guidance Used in Preparation of Human Health Risk Assessment Work Plan

The methods and approach for the BHHRA are based on the following guidance documents:

- *Risk Assessment Guidance for Superfund (RAGS), Part A* (USEPA, 1989)
- RAGS, Part B (USEPA, 1991a)
- *Supplemental Guidance for Human Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities* (CalEPA, 1992)
- *Guidelines for Exposure Assessment* (USEPA, 1992)
- *Exposure Factors Handbook (EFH), Volumes 1 through 3* (USEPA, 1997a)
- *Guidance for the Data Quality Objectives Process* (USEPA, 2000)
- *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002b)
- *Human Health Toxicity Values in Superfund Risk Assessments* (USEPA, 2003a)

- *Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* (USEPA, 2003b,c)
- RAGS, Part E (USEPA, 2004c).

6.2.3 Human Health Conceptual Site Model

Figure 6-1 presents the CSM for human health exposure. The sections below discuss potential receptors and complete or potentially complete exposure pathways.

6.2.3.1 Receptors

Human receptors were identified based upon current and potential future uses of OU-A. OU-A is designated for use as trail and parkland. Future construction and maintenance activities are expected to occur as well. Based on this information, the following receptors were evaluated as the most likely and heavily exposed human receptors at OU-A:

- **Construction Worker:** This adult receptor was evaluated in the event extensive soil intrusive activities occur at OU-A.
- **Maintenance/Utility Worker:** This adult receptor was evaluated to account for potential short-term maintenance activities and to address potential repair activities on underground utilities at OU-A.
- **Recreational Visitor:** Because OU-A will be a park/trail, two separate sets of recreators were evaluated, an occasional visitor and a frequent visitor (such as a jogger) living near the site. The occasional visitor was evaluated as both a child and adult and was assumed to engage in mainly passive recreational activities (e.g., walking). Because young children are not expected to run long distances or frequently for exercise, the frequent visitor was evaluated only as an adult receptor.

6.2.3.2 Relevant, Complete, and Significant Exposure Pathways for Soil

Potential exposure pathways for soil for human receptors are presented on Figure 6-1. Potentially complete and significant exposure pathways are identified with a check in the appropriate box for each identified receptor.

Generally, chemicals detected in site media can come in contact with a potential receptor through one or more exposure routes. Based on the expected activities of the receptors selected for OU-A (Figure 6-1), the following site-related complete and significant exposure pathways were quantified for soil.

Incidental Soil Ingestion

The intake of chemicals from incidental soil ingestion is directly related to the amount of soil ingested. All receptors at OU-A may ingest surface soil particles that adhere to food, cigarettes, or their hands. Construction workers and maintenance/utility workers may also incidentally ingest subsurface soil while performing intrusive soil activities. Therefore, this exposure pathway was considered to be potentially complete for all human receptors and was evaluated quantitatively in the BHHRA.

Dermal Contact with Soil

All receptors at OU-A may come into direct dermal contact with chemicals in surface soil. Both construction workers and the maintenance/utility workers may also come into direct contact with chemicals in subsurface soil during invasive soil activities. Therefore, this exposure pathway was considered to be potentially complete for all human receptors and was evaluated quantitatively in the BHHRA.

Inhalation of Particulates from Soil

All receptors at OU-A may be exposed to chemicals adsorbed to airborne surface soil particles. Construction and maintenance/utility workers may also be exposed to airborne subsurface soil particles generated during invasive soil activities. Therefore, this exposure pathway was considered to be potentially complete for all human receptors and was evaluated quantitatively in the BHHRA.

Inhalation of Vapors from Soil or Groundwater

Inhalation of volatile emissions occurs through the direct volatilization of VOCs from soil and/or groundwater to ambient air and is a potentially complete pathway for all receptors. The chemicals that were evaluated for this pathway were only those that met the CalEPA (1994) definition of a VOC, those chemicals with a vapor pressure greater than 1×10^{-3} millimeters of mercury and a Henry's Law Constant greater than 1×10^{-5} atmosphere-cubic meter per mole.

At OU-A, inhalation of vapors in ambient air is considered a potentially complete pathway and was evaluated for all detected VOCs for all receptors. Considering the general absence of VOCs in the coastal portions of OU-A (based on current data), the prevalence of high-wind conditions, and expected short exposure times, exposure to VOCs in ambient air would be minimal and may be insignificant, especially for recreators. However, as an added measure of conservatism and at the request of the regulatory agencies, this pathway was evaluated quantitatively for all receptors.

6.2.3.3 *Groundwater-Related Exposure Pathways*

As noted previously in Section 6.1, neither surface water (i.e., springs and/or seeps) nor groundwater represent a significant source of chemical impact to humans. Although the exposure pathway related to inhalation of volatile chemicals or contact with chemicals in groundwater during construction activities is potentially complete, VOCs are not considered COPCs in groundwater. For this reason, the water-related exposure pathways are incomplete or insignificant and were not quantified in this assessment.

6.2.3.4 *Summary of Receptors and Corresponding Exposure Pathways*

Based on the information discussed in the preceding sections, the following exposure pathways were identified as complete and significant and were quantified in the BHHRA.

Construction Worker

Soil Depth Range Exposure: Surface and subsurface soil (0 to 10 feet bgs) – the potentially complete exposure pathways include:

- Inhalation of vapors in ambient air during soil invasive activities
- Inhalation of particulates in ambient air during soil invasive activities
- Dermal contact with surface and subsurface soil
- Incidental ingestion of surface and subsurface soil.

Maintenance/Utility Worker

Soil Depth Range Exposure: Surface and subsurface soil (0 to 10 feet bgs) – the potentially complete exposure pathways include:

- Inhalation of vapors in ambient air during soil invasive activities
- Inhalation of particulates in ambient air during soil invasive activities
- Dermal contact with surface and subsurface soil
- Incidental ingestion of surface and subsurface soil.

Occasional and Frequent Recreational Visitor

Soil Depth Range Exposure: Surface soil – the potentially complete exposure pathways include:

- Inhalation of vapors in outdoor air
- Inhalation of particulates in outdoor air
- Dermal contact with surface soil
- Incidental ingestion of surface soil.

6.2.4 Exposure Assessment

Exposure assessment is the process of estimating the magnitude of exposure to human receptors potentially exposed to environmental contaminants. It includes information regarding the development of media-specific EPCs, as well as the parameters and models necessary to estimate human exposure through dermal absorption, ingestion, and inhalation. Consistent with USEPA (1989) guidance, each receptor was evaluated under both a typical exposure (central tendency estimate [CTE]) and a worse case (reasonable maximum estimate or exposure [RME]) scenario. And as noted in Section 6.2.3, the recreational scenario was quantified evaluating an occasional child and adult visitor (which is assumed to be the CTE scenario) and a frequent visitor or jogger (which is assumed to be the RME scenario).

6.2.4.1 Human Health Risk Assessment Exposure Point Concentrations

The EPC is the representative concentration of a COPC in an environmental medium that is potentially contacted by a receptor. As noted earlier in Section 6.1.4, EPCs were estimated using USEPA's ProUCL 4.0 software program (Appendix G).

Soil Exposure Point Concentrations

The EPCs for soil were calculated using soil data collected in OU-A. Soil EPCs were used in the route-specific intake equations described in Section 6.2.4.2 for estimating exposure associated with incidental soil ingestion and dermal contact. As discussed in Section 6.1.3, the 0- to 0.5-foot bgs depth interval for soil was used to estimate all EPCs because that depth interval had the highest EPCs.

Air Exposure Point Concentrations

The inhalation of chemicals adsorbed to airborne soil dust particles is considered a potentially complete exposure pathway for all receptors evaluated in this assessment. The inhalation of VOCs in ambient air may also be a potentially complete exposure pathway.

Fate and transport models were applied to soil data to estimate EPCs for volatile chemicals in these matrices. As discussed previously, the volatilization of VOCs to ambient air pathway was only evaluated for those chemicals that met the CalEPA (1994) definition of a VOC. Chemicals that did not meet the CalEPA definition of a VOC were treated as non-VOCs. Potential exposure to chemicals adsorbed to airborne soil particles were only evaluated for non-VOCs.

For outdoor ambient air exposure to VOCs migrating from soil during soil intrusive activities, soil-to-air volatilization factors (VFs; Table 6-6) were derived using methods consistent with equations and default assumptions provided in the USEPA's (2002b) Soil Screening Guidance (summarized below). The 95% UCL soil EPCs were used with the VFs to derive the air EPCs.

$$VF = \frac{Q/C_{vol} \times (3.14 \times D_A \times T)^{1/2} \times 10^{-4} (m^2/cm^2)}{(2 \times \rho_b \times D_A)}$$

Where:

$$D_A = \left[(\theta_a^{10/3} D_i H_i' + \theta_w^{10/3} D_w) / n^2 \right] / \rho_b K_d + \theta_w + \theta_a H_i'$$

Parameter/Definition (units)	default
VF/volatilization factor (m^3/kg)	chemical-specific
D /apparent diffusivity (cm^2/s)	chemical-specific
Q/C _{vol} /inverse of the ratio of the geometric mean air concentration to the volatilization flux at center of a square source ($g/m^2 \cdot s$ per kg/m^3)	68.18
T/exposure interval (s)	9.5×10^8
ρ_b /dry soil bulk density (g/cm^3)	1.5
θ_a /air-filled soil porosity (L air /L soil)	$n - \theta_w$
n/total soil porosity (L pore /L soil)	$1 - (\rho_b / \rho_s)$
θ_w /water-filled soil porosity (L water /L soil)	0.15
ρ_s /soil particle density (g/cm^3)	2.65
D /diffusivity in air (cm^2/s)	chemical-specific
H'/dimensionless Henry's law constant	chemical-specific
D /diffusivity in water (cm^2/s)	chemical-specific
K _d /soil-water partition coefficient (cm^3/g)	for organics: $K_d = K_{oc} \times f_{oc}$
K _{oc} /soil organic carbon partition coefficient (cm^3/g)	chemical-specific
f _{oc} /fraction organic carbon in soil (g/g)	0.006 (0.6%)

Fugitive Soil Dust Emissions

Potential exposure to non-VOCs adsorbed to soil particles and released to air from wind erosion or during soil invasive activities was evaluated using particulate emission factors (PEFs; Table 6-6). In the absence of available site-specific data, default PEF

values were used. Because the amount of particulates in the air is highly dependent on the level of soil disturbance activity, two default PEF values were considered. To evaluate recreational receptors, the PEF derived from the calculations used for the USEPA Region 9 PRGs (USEPA, 2004a) was used. For the construction workers and maintenance/utility workers, DTSC's (2005) recommended PEF value for an RME construction scenario was used.

In addition to potential exposure to receptors within OU-A from airborne soil particles, there is also the potential for airborne particle transport to other OUs (e.g., OU-C and OU-D). The potential exposure to receptors at other OUs was evaluated by application of the USEPA (1995a) SCREEN3 air dispersion model. For modeling purposes, OU-A North and OU-A South were treated as separate area sources. For consistency with the estimation of air soil particle emissions within OU-A, the airborne soil particle concentration (0.758 ug/m^3) was estimated using PEFs for soil at 0 to 0.5 feet bgs and was used as the input concentration in the model. In the absence of complete meteorological data for the City of Fort Bragg, it was assumed that the maximum wind speed for each month occurred during each event. It was conservatively assumed that no precipitation occurs and that soil is dry and erodible throughout the entire year. Although wind direction is seasonally variable in the Fort Bragg coast area, it was assumed that wind direction was westerly throughout the entire year. As illustrated in Figures 6-1a and 6-1b for OU-A North and OU-A South, respectively, there is an approximately 4-fold decrease in airborne soil particle concentration at 1,000 meters from both OU-A North and OU-A South.

6.2.4.2 Dose (Intake) Estimation

When evaluating exposure to noncarcinogens, doses are estimated as average daily doses (ADDs), calculated as the average exposure over the time the receptor is assumed to be exposed to the COPC. When evaluating exposure to potential carcinogens, lifetime average daily doses (LADDs) are calculated by averaging exposure over a 70-year timeframe. Exposures were calculated using the dose equations consistent with those recommended by USEPA (1989, 2004a) for the potentially complete exposure pathways identified previously in Section 6.2.3.

Soil and air EPCs were mathematically combined with applicable receptor-specific exposure parameter values to estimate exposures consistent with the USEPA's (1989) definition of the RME dose for each related exposure pathway.

Exposure parameter values were developed from two primary sets of sources:

- CalEPA (1992, 1994) risk assessment guidance
- USEPA (1989, 1991a, 1997a, 2002b, 2004a,b,c) risk assessment guidance.

CalEPA (1992, 1994) exposure parameter values were generally used to estimate ADDs and LADDs. However, for specific exposure parameters, CalEPA recommends using more current USEPA guidance, specifically USEPA (2004c) guidance for assessing dermal exposures. Both CTE and RME assumptions were developed to provide a range of risk estimates and acknowledge the uncertainty associated with estimating patterns of exposure. Table 6-7 summarizes the exposure parameters and Table 6-8 summarizes the dermal absorption factors used for all receptors evaluated in this assessment.

The following are the primary equations used for dose calculations.

Incidental Ingestion of Soil

The doses of constituents associated with incidental ingestion of soil were calculated as follows:

Equation 6-1:

$$Dose = \frac{C_S * IR_S * CF * FI * EF * ED}{BW * AT}$$

Where:

- Dose = ADD or LADD (milligrams per kilogram per day [mg/kg-day])
- C_S = COPC concentration in soil or sediment (mg/kg)
- IR_S = soil ingestion rate (milligrams per day [mg/day])
- CF = conversion factor (1 × 10⁻⁶ mg/kg)
- FI = fraction ingested from contaminated source (unitless)
- EF = exposure frequency (days/year)

ED = exposure duration (years)

BW = body weight (kg)

AT = averaging time (days)

Dermal Contact with Soil

Absorbed doses of constituents associated with dermal contact with soil were calculated as follows:

$$Dose = \frac{C_S * CF * SA * AF * ABS_d * EF * ED}{BW * AT}$$

Where:

Dose = ADD or LADD (mg/kg-day)

C_S = COPC concentration in soil or sediment (mg/kg)

CF = conversion factor (1 × 10⁻⁶ mg/kg)

SA = skin surface area available for contact (square centimeters [cm²])

AF = soil- or sediment-to-skin adherence factor (milligrams per square centimeter per day [mg/cm²-day])

ABS_d = dermal absorption factor (unitless) (Table 6-8)

EF = exposure frequency (days/year)

ED = exposure duration (years)

BW = body weight (kg)

AT = averaging time (days)

Volatile chemicals in the soil were given an ABS value of zero and, therefore, not evaluated via the dermal pathway. Due to the low concentrations of VOCs at OU-A,

evaluating dermal exposure to VOCs was deemed overly conservative. VOCs are adequately evaluated through the assessment of the inhalation exposure pathway (USEPA, 2004c).

Inhalation of Fugitive Dust Particles and Volatile Compound Emissions

Doses associated with the inhalation of VOCs or constituents associated with fugitive dust particles from ambient air were calculated as follows:

$$Dose = \frac{C_a * BR * ET * EF * ED}{BW * AT}$$

And:

$$C_a = C_s * PEF^{-1} \quad \text{or} \quad C_a = C_s * VF^{-1}$$

Where:

- Dose = ADD or LADD (mg/kg-day)
- C_a = COPC concentration in air (mg/m³)
- BR = inhalation rate or breathing rate (m³/hour)
- ET = exposure time (hours/day)
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time (days)
- PEF = particulate emission factor for dust particles (m³/kg)
- VF = volatilization factor for volatile constituents (m³/kg)

6.2.5 Lead Exposure

DTSC's LeadSpread model (CalEPA, 1999) and the USEPA's Adult Lead Methodology (ALM; USEPA, 2003b,c; 2007d) were used to evaluate the potential exposure to lead.

The LeadSpread model calculates upper percentile blood-lead concentrations for adults and children, specifically, the median, 90th, 95th, 98th, and 99th percentile blood-lead concentrations. LeadSpread was used for the child occasional recreator.

USEPA's (2003b,c; 2007d) ALM model was used to assess exposure to construction workers, maintenance/utility workers, and adult recreational visitors, by relating soil-lead intake in women of child-bearing age to blood-lead concentrations in a developing fetus (USEPA, 2003b,c; 2007d). Default estimates were used for the statistical measures of blood lead, including the target 95th percentile blood-lead concentration in fetus, fetal/maternal blood lead ratio ($R_{\text{fetal/maternal}}$), biokinetic slope factor, geometric standard deviation on the population mean blood-lead concentration (GSDi), and baseline blood-lead concentration. Default values were also used for exposure parameters such as the lead absorption fraction and the averaging time.

The ALM calculates 95th percentile blood-lead concentrations by applying a geometric standard deviation to a CTE calculated from the user-specified input parameters. Therefore, all exposure parameters for ALM (and LeadSpread) were set to the CTE values. USEPA (2007c) recommends 100 mg/day as the CTE of soil ingestion rate for construction workers. This value represents the central tendency ingestion rate for soil contact-intensive activities (including soil-derived indoor dust) (USEPA, 1997a; 2002a).

The USEPA (2004c) RAGS Part E guidance assumes a recreational receptor exposure time of one hour per day, and a resultant soil ingestion rate of 100 and 50 mg/day values for recreational child and adult receptors, respectively, which would overestimate a RME for these receptors. The USEPA values are based on studies observed over day-long periods and are not appropriate for an intermittent exposure period, such as that which would occur under the future park/trail usage. The USEPA (2004c) referenced the EFH (USEPA, 1997a) for the ingestion rates, and a study referenced in the EFH suggests a possible 50:50 ratio between outdoor sources and indoor sources (Calabrese et al., 1989; as cited in USEPA, 1997a). Because of a lack of available studies for intermittent exposures for this subject and in consideration of the Calabrese et al. (1989) study, one-half the USEPA residential values are proposed for the recreational receptor soil ingestion rates for OU-A. Values of 50 and 25 mg/day

were selected for recreational child and adult receptors, respectively. These values are likely overestimates but were selected to be conservative.

Calculations were conducted using GSDi of exposed individuals estimates, for both 1) a homogeneous (i.e., similar socioeconomic and ethnic characteristics and living within a small geographic area); and 2) a heterogeneous (i.e., varied socioeconomic, ethnic, and geographic characteristics) population. Documentation for the ALM cites three separate sets of default values for these two GSDi estimates (USEPA, 2003b,c). The most conservative set of input values (i.e., GSDi = hom = 2.1 and GSDi = het = 2.3) were used for estimating exposure.

The ALM provides two equations for estimating exposure. One equation is based on an ingestion rate of soil that includes soil and indoor dust (IR_s). For scenarios in which the proportion of soil to dust is known, a second equation is provided that uses a total ingestion rate of outdoor soil and indoor dust (IR_{s+d}) and weights the fraction of the ingestion rate that is from outdoor soil. However, because the proportion of dust and soil is not known at OU-A, a default assumption that 100% of the soil ingested is from outdoor soil was used.

6.2.6 Toxicity Assessment

CalEPA and USEPA have both derived numerical toxicity values for use in risk assessment. Because the risks associated with exposure to carcinogens are assessed differently than the hazards associated with exposure to noncarcinogens, the toxicity values are derived using different assumptions and methods. The toxicity values to be used in the BHHRA for assessing potential carcinogenic risk and noncarcinogenic hazards are described in Sections 6.2.6.1 and 6.2.6.2, respectively.

The assessment of potential hazard associated with lead exposure is a special case that is evaluated separately, as described in Section 6.2.6.3. Section 6.2.6.4 provides a brief discussion on treatment of chromium and chemicals with no published toxicity values. Tables 6-9 and 6-10 present the toxicity values used to evaluate carcinogenic effects. Noncarcinogenic toxicity values are presented in Tables 6-11 and 6-12.

6.2.6.1 Toxicity Values for Carcinogenic Health Effects

The current approach to carcinogenic risk assessment used by the USEPA (1999, 2003a) and other United States regulatory agencies assumes, without confirmatory studies, that exposure to any carcinogen poses a finite probability, however small, of

producing a carcinogenic response. Cancer slope factors (CSFs) are used in the risk characterization to estimate potential cancer risk and represent the upper-bound probability of carcinogenic response per unit daily intake of a substance over a lifetime. CSFs were used in this BHHRA to assess excess lifetime cancer risk (ELCR) for all receptors. CSFs were selected from the following sources in order of priority:

- CalEPA's Office of Environmental Health Hazard Assessment (OEHHA) Online Toxicity Criteria Database (CalEPA, 2007b)
- USEPA's (2007a) Integrated Risk Information System (IRIS) online database
- USEPA's Provisional Peer Reviewed Toxicity Value (PPRTV) Database (USEPA, 2007b); this source was consulted when CSFs were not available from OEHHA or USEPA's IRIS.

For PCBs, DTSC recommends the CSFs from IRIS, as follows: 2 mg/kg-day⁻¹ for high-persistence PCBs such as Aroclor 1260, 1254, and 1248 and 0.4 mg/kg-day⁻¹ for low-persistence PCBs such as Aroclor 1242. However, because a "total PCB" value was estimated (sum of Aroclors or two times the sum of congeners) rather than individual Aroclors, the CSF of 2 mg/kg-day⁻¹ was used.

6.2.6.2 Toxicity Values for Non Carcinogenic Health Effects

Noncarcinogenic toxicity values are applied in the risk characterization to estimate the potential noncancer hazards associated with chemical exposure. In contrast to the default nonthreshold assumption used for assessing carcinogenic risk, noncarcinogenic effects are assumed by most regulatory agencies, including CalEPA and the USEPA, to exhibit a biological or toxicological threshold below which adverse effects are not expected.

Following USEPA (1989) guidance, chronic reference doses (RfDs) were used in the risk characterization to assess potential noncarcinogenic hazard to recreators and RME maintenance/utility workers with exposure durations greater than seven years. Subchronic RfDs were used in the risk characterization to assess potential noncarcinogenic hazard to construction workers and CTE maintenance/utility workers with exposure durations less than seven years. Whenever a subchronic RfD was unavailable, the chronic RfD was used. Chronic and subchronic noncarcinogenic RfDs used in the BHHRA were obtained from the following sources in order of priority:

- CalEPA's Chronic Reference Exposure Levels (RELs) (CalEPA, 2007a) and the OEHHA Online Toxicity Criteria Database (CalEPA, 2007b)
- USEPA's (2007a) IRIS online database used preferentially for the oral exposure route; however, the more conservative of the CalEPA Chronic REL or the USEPA reference concentration (RfC) was used for the inhalation exposure route, if both were available
- USEPA's (2007b) PPRTV Database; this source was only consulted when RfDs, RELs, and RfCs were not available from OEHHA or IRIS.
- USEPA's (1997b) Health Effects Assessment Summary Tables (HEAST), where chronic RfDs are not available in IRIS (HEAST is the primary source of subchronic RfDs)
- The Agency for Toxic Substances and Disease Registry's (ATSDR, 2007) Minimal Risk Levels for intermediate (i.e., subchronic) values.

In cases where noncarcinogenic toxicity values were not readily available from the above-listed sources, chemicals with similar chemical structure and potentially similar mode of action were used as surrogates for chemicals without toxicity values.

Dermal RfDs were only derived for those COPCs that meet the USEPA (2004c) criteria for adjustment of the oral RfD. For chemicals that do not meet these criteria, oral RfDs were used in the risk characterization to assess hazards associated with dermal exposure.

When necessary, RELs were converted to chronic RfDs using standard default exposure assumptions for adult body weight (70 kg) and adult residential inhalation rate (20 cubic meters per day [m^3/day], which assumes a 24-hour per day exposure).

Not all chemicals have been shown to elicit the same adverse noncarcinogenic response from oral and inhalation exposures. Specifically, inorganic chemicals may have portal-of-entry effects that differ between the oral and inhalation routes. Consistent with USEPA's (2004a) approach for developing PRGs, oral RfDs for metals were not used for the inhalation exposure route. For organic chemicals, oral RfDs were used to assess potential hazard associated with the inhalation exposure route, unless supporting evidence recommends against it. Sections 6.3.10.3 through 6.3.10.5 summarize some special toxicity cases that were considered in this assessment.

6.2.6.3 *Toxicity Assessment for Lead*

Although USEPA (2007a) identifies lead as a “probable human carcinogen” based on sufficient animal evidence, but inadequate human evidence, it and CalEPA (1992) do not recommend evaluating lead cancer risk using a CSF. Instead, the potential hazard associated with lead exposure was evaluated by comparison of the predicted blood-lead concentrations to the blood-lead target concentration from the Centers for Disease Control. The target lead concentration of concern is 10 micrograms per deciliter (µg/dl) of whole blood based on potentially adverse neurological effects in children (CDC, 1991). The models described in Section 6.2.5 were used to estimate blood-lead concentrations in receptors.

6.2.6.4 *Treatment of Chromium and Chemicals Lacking Toxicity Values*

Chromium is primarily found in one of two (or both) valence states in the environment: trivalent chromium (Cr III) and hexavalent chromium (Cr VI). Existing data and knowledge of potential sources onsite indicates that Cr VI is not present at detectable concentrations. Therefore, all chromium present in OU-A was assumed to be Cr III. Furthermore, total chromium analytical results were treated as Cr III.

Quantitative analyses were not performed on COPCs that lack toxicity values or for which a reasonable toxicity surrogate could not be identified.

6.2.7 Risk Characterization

Risk characterization integrates the exposure assessment and the toxicity information. The cancer risk and/or noncancer hazard was calculated for each COPC and for each media and potentially complete exposure pathway. An ELCR is calculated for compounds identified by CalEPA or USEPA as probable human carcinogens. The cancer risk is defined by CalEPA (1994) as “the risk, or theoretical probability of developing cancer from that chemical upon exposure to that medium.”. Excess cancer risk was estimated by multiplying the LADD by the chemical-specific CSF as shown in the following equation:

Equation 6-2:

$$\text{CSF} \times \text{LADD} = \text{Risk Cancer Excess}$$

The total excess cancer risk at OU-A was calculated by summing the risk for each carcinogen over all exposure media and exposure pathways.

A hazard quotient (HQ) is calculated for all COPCs. The HQ is the ratio of the estimated dose from exposure to a compound in a particular medium to the dose that is not expected to result in adverse health effects, other than cancer.

$$HQ = \frac{ADD}{RfD}$$

If the HQ exceeds a value of one, the possibility exists for noncarcinogenic hazard. The HQ is not a mathematical prediction of the severity or incidence of the effects, but rather is an indication that a hazard may exist. Cal/EPA (1994) and USEPA (1989) recommend that the total hazard index (HI) (i.e., the sum of the HQs for all chemicals) not exceed a value of one. If the resulting total HI is greater than one, it may be recalculated summing only hazard quotients for chemicals with a similar mechanism of action or toxic endpoints (USEPA, 1989).

Consistent with CalEPA (1994) guidance, this assessment assumed that ELCRs of greater than 1×10^{-6} or a noncancer HI of greater than one suggest that exposure to chemicals may pose a potential threat to human health. There may be exceptions to these criteria, including elevated background concentrations, other applicable criteria, or specific site circumstances that allow for "a risk management decision to elevate the acceptable screening levels" (Cal/EPA, 1994). USEPA (2003a) recommends a range of acceptable risks of 1×10^{-4} to 1×10^{-6} (one in ten thousand to one in one million).

6.2.8 Results and Conclusions

This section summarizes the results of the BHHRA, separately for the two EUs; the results for OU-A North are presented in Section 6.2.8.1 and those for OU-A South are in Section 6.2.8.2. The results of the lead exposure and toxicity assessment are presented separately in Section 6.3.8.3. Risks are discussed with and without the inclusion of arsenic, because the arsenic EPCs are well within ambient/background conditions.

In all cases, the noncancer HI was well below 1, the agency threshold of concern. The ELCR estimate ranged from 9×10^{-8} and 1×10^{-5} at OU-A North with 91 to 95% of the risk due to background levels of arsenic; all risks are below the 1×10^{-6} point of departure and below the lower end of USEPA's risk range when arsenic is excluded

from consideration. The ELCR estimate ranged from 9×10^{-8} and 8×10^{-6} at OU-A South with 92 to 95% of the risk due to background levels of arsenic; all risks are below the 1×10^{-6} point of departure and below the lower end of USEPA's risk range when arsenic is excluded from consideration.

Cancer risks and hazard indices are summarized Tables 6-13 (OU-A North) and 6-14 (OU-A South). Appendix H presents chemical-specific results for each receptor.

6.2.8.1 Operable Unit A North

Construction Worker

The cancer risks for the CTE and the RME scenario are 4×10^{-7} and 4×10^{-6} , respectively. The CTE estimate is below CalEPA's (1994) threshold of 1×10^{-6} for carcinogenic effects, and the RME scenario risk is slightly above the threshold. However, arsenic accounts for 91% (CTE scenario) and 94% (RME scenario) of the total risk estimate. The total risks, excluding arsenic, for this receptor are 4×10^{-8} and 2×10^{-7} for the CTE and RME scenarios, respectively.

The noncancer HIs for this receptor are 0.06 (CTE scenario) and 0.3 (RME scenario). The HI estimates, excluding arsenic, are 0.01 and 0.09 for the CTE and RME scenarios, respectively. In all cases, the HIs are equal to or below CalEPA's (1994) threshold level of one for noncancer effects.

The results for this receptor are summarized in Table 6-13. Chemical-specific cancer and noncancer results are presented in Tables H-1 (CTE scenario) and H-2 (RME scenario).

Maintenance/Utility Worker

The cancer risks for the CTE and the RME scenario are 9×10^{-8} and 2×10^{-6} , respectively. The CTE estimate is below CalEPA's (1994) threshold of 1×10^{-6} for cancer effects, and the RME scenario risk is slightly above the threshold. However, arsenic accounts for 91% (CTE scenario) and 94% (RME scenario) of the total risk estimate. The total risks, excluding arsenic, for this receptor are 9×10^{-9} and 1×10^{-7} for the CTE and RME scenarios, respectively. Both estimates are below CalEPA's threshold for carcinogenic effects.

The noncancer HIs for this receptor are 0.01 (CTE scenario) and 0.03 (RME scenario). The HI estimates, excluding arsenic, are 0.003 and 0.007 for the CTE and RME scenarios, respectively. In all cases, the HIs are equal to or below CalEPA's (1994) threshold level of one for noncancer effects.

The results for this receptor are summarized in Table 6-13. Chemical-specific cancer and noncancer results are presented in Tables H-3 (CTE scenario) and H-4 (RME scenario).

Occasional and Frequent Recreational User

Consistent with the methods summarized in Section 6.2.3, the CTE scenario was based on the evaluation of the child/adult occasional visitor. The adult frequent visitor (jogger) was evaluated to account for the RME scenario. The results of this evaluation are presented below. For the CTE scenario, the child and adult occasional visitor cancer risks have been summed in the discussion below (to estimate a lifetime exposure) and the RME (frequent visitor/jogger) are presented separately. The HIs for the individual recreators are presented individually.

The cancer risks for the child and adult occasional visitor (CTE scenario) and the adult frequent visitor/jogger (RME scenario) are 4×10^{-6} and 1×10^{-5} , respectively. These scenarios are above CalEPA's (1994) threshold of 1×10^{-6} for cancer effects. However, arsenic accounts for 95% (CTE) and 93% (RME) of the total risk estimate. Total risks, excluding arsenic, for this receptor are 3×10^{-7} and 7×10^{-7} for the CTE and RME scenarios, respectively. These risk estimates are below CalEPA's threshold for carcinogenic effects.

The noncancer HIs for this receptor are 0.02 and 0.005 (CTE scenario; child and adult, respectively) and 0.03 (RME scenario). The HI estimates, excluding arsenic, are 0.007 and 0.003 (CTE; child and adult, respectively) and 0.03 (RME scenario). In all cases, the HIs are below CalEPA's (1994) threshold level of one for noncancer effects.

The results for this receptor are summarized in Table 6-13. Chemical-specific cancer and noncancer results are presented in Tables H-4 and H-5 (CTE scenario, child and adult occasional visitor) and H-6 (RME scenario, frequent visitor).

6.2.8.2 Operable Unit A South

Construction Worker

The cancer risks for the CTE and the RME scenario are 4×10^{-7} and 4×10^{-6} , respectively. The CTE estimate is below CalEPA's (1994) threshold of 1×10^{-6} for carcinogenic effects, and the RME scenario risk is slightly above the threshold. However, arsenic accounts for 92% (CTE scenario) and 95% (RME scenario) of the total risk estimate. The total risks, excluding arsenic, for this receptor are 1×10^{-7} and 5×10^{-7} for the CTE and RME scenarios, respectively.

The noncancer HIs for this receptor are 0.1 (CTE scenario) and 0.7 (RME scenario). The HI estimates, excluding arsenic, are 0.1 and 0.5 for the CTE and RME scenarios, respectively. In all cases, the HIs are equal to or below CalEPA's (1994) threshold level of one for noncancer effects.

The results for this receptor are summarized in Table 6-14. Chemical-specific cancer and noncancer results are presented in Tables H-13 (CTE scenario) and H-14 (RME scenario).

Maintenance/Utility Worker

The cancer risks for the CTE and the RME scenario are 1×10^{-7} and 2×10^{-6} , respectively. The CTE estimate is below CalEPA's (1994) threshold of 1×10^{-6} for cancer effects, and the RME scenario risk is slightly above the threshold. However, arsenic accounts for 93% (CTE scenario) and 95% (RME scenario) of the total risk estimate. The total risks, excluding arsenic, for this receptor are 2×10^{-8} and 3×10^{-7} for the CTE and RME scenarios, respectively. Both estimates are below CalEPA's threshold for carcinogenic effects.

The noncancer HIs for this receptor are 0.03 (CTE scenario) and 0.06 (RME scenario). The HI estimates, excluding arsenic, are 0.02 and 0.04 for the CTE and RME scenarios, respectively. In all cases, the HIs are equal to or below CalEPA's (1994) threshold level of one for noncancer effects.

The results for this receptor are summarized in Table 6-14. Chemical-specific cancer and noncancer results are presented in Tables H-15 (CTE scenario) and H-16 (RME scenario).

Occasional and Frequent Recreational User

Consistent with the methods summarized in Section 6.2.3, the CTE scenario was based on the evaluation of the child/adult occasional visitor. The adult frequent visitor (jogger) was evaluated to account for the RME scenario. The results of this evaluation are presented below. For the CTE scenario, the child and adult occasional visitor cancer risks have been summed in the discussion below (to estimate a lifetime exposure) and the RME (frequent visitor/jogger) are presented separately. The HIs for the individual recreators are presented individually.

The cancer risks for the child and adult occasional visitor (CTE scenario) and the adult frequent visitor/jogger (RME scenario) are 3×10^{-6} and 8×10^{-6} , respectively. These scenarios are above CalEPA's (1994) threshold of 1×10^{-6} for cancer effects. However, arsenic accounts for 95% (CTE) and 94% (RME) of the total risk estimate. The total risks, excluding arsenic, for this receptor are 2×10^{-7} and 5×10^{-7} for the CTE and RME scenarios, respectively. These risk estimates are below CalEPA's threshold for carcinogenic effects.

The noncancer HIs for this receptor are 0.02 and 0.004 (CTE scenario; child and adult, respectively) and 0.03 (RME scenario). The HI estimates, excluding arsenic, are 0.006 and 0.007 and 0.003 (CTE scenario; child and adult, respectively) and 0.02 (RME scenario). In all cases, the HIs are below CalEPA's (1994) threshold level of one for noncancer effects.

The results for this receptor are summarized in Table 6-14. Chemical-specific cancer and noncancer results are presented in Tables H-17 and H-18 (CTE scenario, child and adult occasional visitor) and H-19 (RME, frequent visitor).

6.2.8.3 Lead Exposure

This section summarizes the results of the lead exposure evaluation. The results are summarized in Tables 6-15 and 6-16 for OU-A North and OU-A South, respectively. The lead evaluation spreadsheets used for each receptor are presented in Appendix H.

The 95th percentile child and adult receptor-specific blood-lead level estimates evaluated in this assessment for both EUs are identical and well below the agency threshold blood-lead level of 10 µg/dl. The estimated blood-lead level for both the construction worker and the maintenance/utility worker were both 1.7 µg/dl (Table 6-15). The estimated blood-lead levels for the child and adult recreational

visitors were 3.5 and 1.7 µg/dl, respectively. All fetal blood-lead levels predicted for pregnant workers or visitors through ALM were also below the agency threshold blood-lead level of 10 µg/dl. Receptor-specific blood-level spreadsheets are presented in Tables H-8 through H-12 (OU-A North) and Tables H-20 through H-24 (OU-A South).

6.2.8.4 Off-site Exposure to Airborne Soil Particles

In addition to potential exposure to receptors within OU-A from airborne soil particles, there is also the potential for airborne soil particle transport to other OUs. Potential exposures to receptors at other OUs (OU-C and OU-D) were evaluated by application of the USEPA (1995a) SCREEN3 air dispersion model (see Section 6.2.4.1). Potential risks associated with the air dispersion of airborne particle-bound TCDD TEQ concentrations to other OUs were evaluated separately for OU-A North and OU-A South using the EPCs for soil at 0 to 0.5 feet bgs of 21 and 15 pg/g, respectively. Because portions of other OUs may be developed for residential use, the receptors evaluated were adult and child residential receptors. For adult and child residential receptors combined, risks associated with potential airborne transport of soil particles from OU-A North ranged from 7×10^{-11} at 1,000 meters east of the leading edge of OU-A North to 3×10^{-10} at the interface of OU-A North and OU-C. Risks associated with the airborne transport of soil particles from OU-A South ranged from 5×10^{-11} at 1,000 meters east of the leading edge of OU-A North to 2×10^{-10} at the interface of OU-A South and OU-D. These results show that even when using highly conservative modeling assumptions, potential transport of soil particle-bound dioxins/furans potentially to other OUs east of OU-A, does not pose an unacceptable health risk to future residential receptors.

6.2.9 Summary and Conclusions

All noncancer estimates for OU-A were below the agency threshold of one for noncancer (HI) effects and below the 10 µg/dl blood-lead level for each of the receptors.

Arsenic accounts for over 90% of the total cancer risk estimates at OU-A; however, the arsenic EPCs are well within ambient/background conditions. With the exception of the recreator receptors, the CTE cancer risk estimates in both EUs were below CalEPA's threshold of 1×10^{-6} for carcinogenic effects, even with arsenic included. Although the threshold of 1×10^{-6} is exceeded in both EUs for both the RME and CTE scenarios for the recreator and the RME scenario for the construction and maintenance/utility

workers, with arsenic included, all risks for all receptors were below 1×10^{-6} once arsenic was excluded.

Based on this assessment, site-related chemicals do not pose an unacceptable risk to future receptors in OU-A. As discussed previously, risk estimates are based on the assumption that five PRAs are addressed through remediation.

6.2.10 Uncertainties Associated with Baseline Human Health Risk Assessment

This section discusses the uncertainties associated with the BHHRA. The goal of the BHHRA was to evaluate the potential for unacceptable health effects. To this end, the assumptions used in this BHHRA reflect estimates based on both a typical/average (CTE) and an upper-bound exposure (RME) estimate. Because generic assumptions for the receptors were used, the risk estimates and HIs calculated in this assessment are not absolute. Below is a brief discussion that addresses the key uncertainties associated with conducting the BHHRA for OU-A and the potential impacts on the outcome.

6.2.10.1 Receptors Evaluated and Relevant, Complete, and Significant Exposure Pathways

A comprehensive assessment of potential human receptors that are likely to be present at OU-A was conducted and resulted in the selection of the construction worker, the maintenance/utility worker, and the recreational user. Based on expected use scenarios and future development plans for OU-A, no other receptors are expected to be more (potentially) exposed to site-related chemicals at OU-A than those evaluated in the BHHRA. Exposure pathways considered complete and significant were evaluated for these receptors. This BHHRA quantified impacts associated with some exposure pathways (i.e., inhalation of VOCs in ambient air) considered insignificant/ minor. The inclusion of such pathways was conservative and may result in an overestimate of health impacts at OU-A.

6.2.10.2 Exposure Assessment

The exposure assessment relied on a number of different exposure intake assumptions, many of which were based on statistical analyses of human populations. As noted earlier, an RME assessment is the "highest exposure that is reasonably expected to occur at the site" (USEPA, 1989) and was conducted as part of this evaluation, and in some cases (Appendix G), EPCs were based on maximum detected concentrations, which will result in an overestimate of health impacts at OU-A.

6.2.10.3 Lead Exposure

As noted in Section 6.2.5, lead exposure was evaluated using both the LeadSpread exposure model for children and the USEPA's ALM for adults. Key assumptions associated with each model are discussed below.

Unlike the ALM model, LeadSpread utilizes an "applied" dose (versus absorbed); this assumption is also likely to result in overestimates of blood-lead levels.

The ALM model may not be appropriate for evaluating lead exposure to individuals that have intermittent exposures of less than 90 days. Assumed exposures for maintenance/utility workers may not constitute sufficient lengths of time for blood-lead levels to reach a steady state. Exposure estimates generated by the ALM model may be conservative, and therefore may contribute to overestimates of health impacts at OU-A.

The ALM model relates soil lead intake in women of child-bearing age to blood-lead concentrations in a developing fetus, and pregnant women are not likely to be assigned heavy construction work. Thus, this model may contribute to an overestimate of health impacts for the construction worker.

6.2.10.4 Toxicity Assessment

Route-to-route extrapolations were used to evaluate noncarcinogenic effects resulting from potential exposure to organic constituents. There is considerable uncertainty associated with the absorption of constituents via different routes of exposure. This uncertainty may contribute to an overestimate or underestimate of risk.

Arsenic and other COPCs were assumed to be 100% bioavailable. In the case of arsenic, studies have shown that arsenic seldom has a bioavailability of more than 40% and bioavailability could be as low as less than 1% (Ruby et al., 1996; Yang et al., 2003). Therefore, risks due to exposure to arsenic would likely be one-third to one-tenth lower than those calculated.

Carcinogenic risks from exposures to naphthalene were not evaluated initially because USEPA does not currently recommend SFs for naphthalene. The CalEPA (2007b) slope factor for naphthalene, however, should have been used to be consistent with the methodology in Section 6.2.6.1. If the CalEPA SF for naphthalene is used, the highest estimated cancer risk for any receptor is 1×10^{-11} , which is insignificant.

6.2.10.5 Risk Characterization

Risk estimates are based on the assumption that OU-A is unpaved and receptors are directly exposed to surface soil. In the future-use scenario, some of OU-A may be paved, covered with boardwalks, or landscaped such that exposure to soils evaluated in this BHHRA will not occur at the frequency and to the degree assumed in this assessment.

Risk estimates and HIs do not account for the potential synergistic effects of chemicals. However, data are typically unavailable to determine the potential impacts of such synergism on the results of the BHHRA.

6.3 Ecological Risk Assessment

6.3.1 Purpose and Objectives

The purpose of this ERA is to provide an assessment of risk for ecological receptors that may be exposed to COPCs in environmental media in OU-A. As part of the ERA, uncertainties that have the potential to impact the utility of risk conclusions in a risk management, decision-making context are identified, as are additional steps or evaluations necessary to support risk management decision-making based on resulting risk conclusions and identified uncertainties. It is important to note that risk conclusions presented in this report are considered to apply to “current conditions,” but that baseline risk calculations presented herein incorporate an assumption that higher concentrations of some COPCs will be removed via the remediation of the PRAs described previously in Sections 5 and 6. In other words, the conclusions contained in this report apply to a post-remedy condition assuming that the PRAs are addressed, and that “clean” fill material is used to replace soil that currently occupies the PRAs.

The objectives are achieved by completing a scoping assessment, or problem formulations step, followed by the implementation of a two-step ERA process consistent with guidance provided by DTSC (1996) for a predictive ERA and USEPA’s (1997c) Ecological RAGS. The two-step process includes a screening-level ERA (SLERA) and a baseline ERA (BERA). Figure 6-2 presents a flowchart that outlines the USEPA ERA framework.

The objective of the SLERA is typically to separate areas, indicator species, or contaminants at OU-A into two categories: those that have risk below a relevant level of concern and can be eliminated from further assessment; and those where risk

cannot be ruled out and may require further evaluation. Although the SLERA is typically used as a screening step to focus the baseline risk assessment, the SLERA step will not, in this case, be used to screen out COPC-receptor pairs for further evaluation due to concerns about the ability of the SLERA approach to address cumulative exposures across OUs in the context of an OU-specific risk assessment.

The BERA is generally used to further assess areas, indicator species, or contaminants that could not be ruled out by the SLERA. In this case, the objective of the BERA is to provide a more conclusive evaluation of the level of ecological risk, if any, presented by site contaminants. Results from the BERA aid the risk manager in determining whether further evaluation is warranted or if site management action is required.

6.3.2 Ecological Risk Assessment Approach Overview

The ERA presented herein consists of a problem formulation step that includes the development of a preliminary CSM, comparison of media concentrations to background or reference concentrations, as appropriate (e.g., COPC selection), and completion of the SLERA using conservative screening values and screening-level dose estimates using conservative assumptions. The *Site-Wide Risk Assessment Work Plan* (ARCADIS BBL, 2007h) describes the general methodology used to conduct the OU-A risk assessment, including applicable benchmarks, TRVs, potential terrestrial exposure pathways, and representative receptors for terrestrial habitats.

As discussed above, a SLERA was conducted, but no COPCs were eliminated at the SLERA phase based on comparison to screening values. A BERA was then completed using more site-specific assumptions. This phased approach provides a practical method for evaluating the biological and analytical data collected for OU-A.

In a SLERA (Phase I), conservative exposure estimates and model assumptions are used so that potential risk is generally overestimated. Thus, if the screening concludes that negligible risk exists, then a no further action recommendation is typically supported. Conversely, an indication of potential risk in the SLERA stage does not necessarily mean that there is risk associated with an area, species, or contaminant. Rather, this outcome suggests that further evaluation may be justified before a decision can be made. All COPCs evaluated in the SLERA were evaluated in the BERA.

The BERA (Phase II) was completed using less conservative, but more realistic assumptions than those used in the SLERA. This approach included incorporating

more reasonable assumptions of exposure based upon site use, rather than defaulting to conservative estimates that were used in the SLERA. It also included more realistic estimates of COPC concentrations in OU-A environmental media.

Both the SLERA and BERA risk calculations incorporated the PRAs that were identified as discussed in Sections 5 and 6. It is important to note that the PRAs were defined by factors not solely related to risk considerations and those components of the PRA decision that were risk-based were primarily based on human health protection. It is assumed that any future actions would include addressing the PRAs. PRAs were used as a tool to improve the utility of the BERA by emphasizing areas of potential risk that may exist outside of the PRAs.

6.3.3 Problem Formulation

The problem formulation step defines the goals and objectives of the ERA. This is a formal process to develop and evaluate preliminary hypotheses concerning the likelihood and causes of ecological effects that may have occurred, or may occur, from human activities (USEPA, 1998). The problem formulation typically includes the following steps.

1. Evaluation of the ecological setting of the site
2. Development of a CSM, which includes:
 - a. Determining potential exposure media
 - b. Identification of COIs and selection of COPCs
 - c. Identifying potentially complete exposure pathways
 - d. Identifying potential ecological receptors
3. Development of risk questions (RQs)
4. Selection of assessment endpoints (AEs) and associated measurement endpoints (MEs)

These four steps were accomplished during the scoping assessment.¹ The following four sections provide an overview of the ERA-specific problem formulation approach used in this assessment, including both the preliminary scoping assessment findings and the development of a CSM based on those findings.

6.3.3.1 *Ecological Setting*

The first step in the problem formulation process was defining the ecological setting found within OU-A. The scoping assessment provided in the *Site-Wide Risk Assessment Work Plan* (ARCADIS BBL, 2007h) included a review of ecological resource studies conducted for the site and site visits to further to define current conditions. The following table lists the habitat types present within OU-A as identified in the OU-A scoping assessment. With respect to relative spatial coverage, existing habitats are characterized as does not exist (DNE), limited/isolated (L/I), exists (E), and predominates (P).

Operable Unit	Paved/Disturbed	Terrestrial	Aquatic	Marine
OU-A (Trail)	L/I	P	DNE	DNE

DNE – the habitat/land condition type is not present in the OU

L/I – the habitat/land condition type is present in only small areas of the OU that are not connected to or contiguous with other patches of similar habitat/land condition

Exists – the habitat/land condition type is present, but cannot necessarily be classified as the most prevalent habitat/land condition type, or as a limited or isolated component of the OU

Predominates – the habitat/land condition type makes up the majority of a given OU.

It should be noted that although Paved/Disturbed habitats are listed as “L/I” above, that finding is based on observations across OU-A; some areas within OU-A, specifically OU-A North, are mainly Paved/Disturbed areas.

¹ OU-A consists primarily of terrestrial habitat. The *Site-Wide Risk Assessment Work Plan* (ARCADIS BBL, 2007h) provides a general scoping assessment for terrestrial habitats on the former mill site, the outcome of which describes potentially complete pathways, relevant receptors, etc. The results of that scoping assessment are considered to apply directly to OU-A.

Most of the available information describing site ecology is not OU-specific and applies on a site-wide basis, although more specific information is available for OU-A because many of the recent studies and surveys focused on this area in support of permitting activities related to recent site work (e.g., debris removal and investigation work) in OU-A. However, some of the information presented below is generic to the entire site.

The majority of the former mill site, approximately 80 percent (TRC, 2003), is developed industrial land, characterized by large areas covered with structures/foundations, asphalt, crushed rock, or a mixture of both, with occasional weedy ruderal vegetation such as sow thistle (*Sonchus asper*), wild radish (*Raphanus sativa*), and Italian ryegrass (*Lolium multiflorum*) (WRA, 2005). Where no hard cover is present, such as in the former storage yards on the southern end of OU-A (Parcels 8 and 10), soils tend to be highly compacted and sometimes mixed with woodchips, with some areas dominated by common species such as subterranean clover (*Trifolium subterraneum*), Italian ryegrass, and white clover (*Trifolium repens*).

The unpaved/undisturbed areas along the coastline of OU-A contain ecological habitat. The bluffs along the coastline are characterized by coastal bluff scrub communities, dominated by bluff lupine (*Lupinus littoralis*), seaside daisy (*Erigeron glaucus*), sea pink (*Ameria maritima*), gum plant (*Grindelia stricta*), and the exotic iceplant (*Carpobrotus edulis*). Near the Johnson property, the vegetation is characteristic of the coastal terrace prairie community. This community is listed as a sensitive community in the California Natural Diversity Database (CNDDB; <http://www.dfg.ca.gov/bdb/html/cnddb.html>). However, only small fragments of this community persist at OU-A, and most of these have been highly impacted with many natives replaced by weedy exotics. The majority of OU-A South is dominated by non-native grasslands.

OU-A is utilized by a variety of wildlife including non-special status birds, deer, rabbits, ground squirrels, and other rodents. A list of observed animal and plant life from WRA's 2005 biological assessments (updated in 2007; see ARCADIS BBL, 2007h [Appendices A and B]) and a discussion of the special-status species occurring or potentially occurring in OU-A is presented below.

Special-status species present or likely to be present have been defined through literature reviews (CNDDB) and site surveys. WRA (2005; ARCADIS BBL, 2007h) reported observations of osprey (*Pandion haliaetus*), a California Department of Fish and Game Species of Special Concern (CSC), foraging in the ocean near OU-A. Osprey are known to nest along ocean shores; however, no nesting sites were observed in the project area. WRA also reported that there is a moderate chance for

western snowy plover (*Charadrius alexandrinus nivosus*), a federally threatened and CSC, presence in the project vicinity. Western snowy plovers utilize sandy beaches; however, because of high tides and human activity, nesting is unlikely to occur (WRA, 2005; ARCADIS BBL, 2007h). Additionally, there are no beach areas within the specific boundaries of OU-A. Although these species may be observed and/or occur at times onsite, these species do not nest onsite and are not expected to obtain a significant portion of their diet from OU-A.

Short leaved evax (*Hesper-evax sparsiflora* var. *brevifolia*) populations, a California Native Plant Society (CNPS) List 2 species (rare, threatened, or endangered in California, but more common elsewhere), were found along the bluff edge at Glass Beaches 2 and 3 (Figure 6-3) and may be present in other locations on the site. Typical short leaved evax habitat consists of coastal bluff scrub and coastal dunes between 0 to 215 meters in elevation (WRA, 2005; ARCADIS BBL, 2007h).

Mendocino Coast Indian Paintbrush (*Castilleja mendocinensis*) populations, a CNPS List 1B species (endangered, threatened, or rare in California), were found along the bluff edge at Glass Beaches 1, 2, and 3, and on cliff faces of Parcel 10 (Figure 6-3). Typical Mendocino Coast Indian Paintbrush habitat consists of coastal bluff scrub, coastal dunes, coastal prairie, coastal scrub, and closed cone coniferous forests between 0 and 160 meters of elevation (WRA, 2005; ARCADIS BBL, 2007h).

A population of 50 individuals of Blasdale's bent grass (*Agrostis blasdalei*), a CNPS List 1B species (endangered, threatened, or rare in California), was observed at Glass Beach 3 along or proximal to the bluff edge (Figure 6-3). Typical Blasdale's bent grass habitat consists of coastal bluff scrub, coastal dunes, and coastal prairie between 5 and 150 meters in elevation (WRA, 2005; ARCADIS BBL, 2007h).

6.3.3.2 Conceptual Site Model Development: Exposure Media and Pathways

The CSM considers the ecological components of the site setting and identifies important chemicals, site media, ecological exposure pathways and potential pathways of contaminant transport, and receptors (USEPA, 1998). Specifically, the CSM schematically presents the relationship between potentially contaminated environmental media and classes of receptors at the site, and identifies potentially complete and significant pathways through which ecological receptors may be exposed to the identified environmental media. The information gathered on site media and ecological resources during the scoping assessment was integrated to develop a CSM for OU-A. A graphical representation of the OU-A CSM is presented in Figure 3-1. This

figure includes all relevant exposure sources, pathways, and ecological receptors. A graphical depiction of the simplified OU-A food web addressed by this risk assessment is presented in Figure 6-4. The food web is an expansion of the “contaminated biota” pathway shown in Figure 3-1.

COIs are any chemical that could have been associated with former site operations and that may have been introduced into exposure media. COIs were identified during the RI Work Plan stage and are discussed in Section 3; the nature and extent of the COIs detected in the site investigation process is discussed in Section 5. COPCs were selected based on the results of the site characterization data, as discussed in Section 6.1.

As part of the scoping assessment, a review of site environmental media was performed. Media that could potentially be contaminated by a site release and may contain a significant exposure pathway to ecological receptors were considered exposure media. Only soil (and associated biota) was identified as a potential exposure media in OU-A South. OU-A South contains seeps resulting from “daylighting” or emergent groundwater; these seeps are located on the tops of bluffs primarily on the sides of cliffs where little to no ecological exposure could occur. However, because of the potential for these seeps to serve as a pathway for offsite migration of COPCs resulting in potential offsite exposure of aquatic life, seeps are evaluated (screened) as part of this risk assessment.

Soil gas in the form of VOCs was not considered a significant exposure medium because the RI found that the distribution of VOCs within OU-A was highly localized, and that the concentrations of VOCs that were considered COPCs (i.e., those not likely to be laboratory contaminants) were low in magnitude (maximum concentration of total VOCs was less than 0.5 mg/kg in soil and nondetect in groundwater). According to Ecological Soil Screening Levels (EcoSSL) guidance (USEPA, 2003d), only relatively extensive areas of VOCs in soil or VOC plumes in groundwater associated with elevated soil gas concentrations are likely to represent a significant exposure media to ecological receptors. The low levels of VOCs detected in distinctively separate locations are unlikely to result in elevated soil gas concentrations that would pose a risk to burrowing mammals.

OU-A consists almost entirely of upland habitat. Contaminant concentrations in soil were evaluated at two depth intervals for non-burrowing animals and shallow rooting plants: 0 to 0.5 foot bgs and 0 to 2 feet bgs. In general, the 0- to 0.5-foot bgs depth interval presented higher COPC concentrations and, therefore, was selected as the

more conservative representation of site conditions (Section 6.1). For burrowing animals, COPC concentrations in soil from 0 to 6 feet bgs were also evaluated.

Based on the findings of the scoping assessment the following exposure pathways were considered potentially complete:

- Plant direct exposure to soil constituents.
- Soil invertebrate direct exposure to soil constituents.
- Wildlife consumption of contaminated prey items (i.e., plants, invertebrates, and wildlife) and incidental soil ingestion. Non-burrowing wildlife is assumed to be primarily exposed to the upper 0.5 foot of soils and will ingest biota exposed to the top 0.5 foot of soil (more conservative than 0 to 2 feet).
- Potential exposures of offsite aquatic life to seep water.
- Burrowing mammals may be exposed to soil as deep as 6 feet bgs, although prey items would be again exposed to the top 0.5 foot of soil.

6.3.3.3 *Potential Ecological Receptors*

The CSM presented in the *Site-Wide Risk Assessment Work Plan* (ARCADIS BBL, 2007h) was used to identify terrestrial receptor groups that may be exposed to site contaminants, and representative terrestrial receptors were selected for each of these receptor groups. This risk assessment quantitatively evaluated risk to terrestrial ecological receptors associated with each of these groups. As discussed in the *Site-Wide Risk Assessment Work Plan* (ARCADIS BBL, 2007h), it is impractical to assess the toxic effects of COPCs on all potentially exposed ecological receptors. A subset of potential receptors was therefore selected to serve as “representative species” as defined by DTSC (1996), which emphasizes primarily:

- Species that represent a functional group of organisms at the site.
- Species that are chosen based primarily on their function in the ecosystem.
- Secondly, taxonomic relatedness and known or presumed similarities in physiology and life history are considered.

For receptors that are generic in nature (e.g., soil invertebrates and plants), selection of a representative species was not necessary. Therefore, the selection of representative species was only performed for receptors representing upper trophic-level receptor groups. In general, representative species were selected from a subset of species for each receptor group based on a number of considerations. The selection of representative species was not based on an analysis of relative sensitivity based on exposure factors. Rather, representative species were selected based on practical considerations with the goal of selecting sensitive receptors that are believed to be protective of the receptor groups they represent. Specifically, the considerations given to species for receptor selection in this ERA included:

- The species is relevant to the site. Species observed relatively often at the site are likely to use the site to a greater degree than species not commonly observed and, therefore, are likely to be more representative.
- The receptor has a feeding strategy likely to maximize exposure to site-associated contamination and has diet preferences that are representative of the guild in question.
- The receptor has a small relative body size. Smaller species have larger contaminant-absorbing surfaces per unit volume than larger species (Suter, 1993).
- The species is a special status species. Where a general receptor class includes one or more special status species, either a special status species was selected to represent the receptor of interest, or a representative species was selected that is believed to be protective of the special status species.
- The receptor has a small relative home range. Animals with smaller home ranges are likely to spend more time foraging on the site than animals with larger home ranges. However, receptors with larger home ranges included an evaluation of contribution of OU-A exposure to site-wide cumulative exposure risk.
- The receptor-specific life history data (exposure parameters) are readily available.

The representative species selected for terrestrial receptors of interest are presented below.

- **Plants** – specific receptor unnecessary.

- **Soil invertebrates** – specific receptor unnecessary.
- **Herbivorous birds** – California quail (*Callipepla californica*): The California quail was observed onsite during plant and wildlife surveys conducted to support the biological assessment prepared by WRA (2005; ARCADIS BBL, 2007h). Quail feed primarily on legumes and other seeds, as well as green vegetation, arthropods, and fruit; have a relatively small body size; and exposure parameters are readily available. The diet of the quail will be assumed to be composed of 100% plant material.
- **Omnivorous birds (foraging from wetlands)** – Mallard (*Anas platyrhynchos*): The mallard was observed onsite during plant and wildlife surveys conducted to support the biological assessment prepared by WRA (2005; ARCADIS BBL, 2007h). Mallards are not typically used as an upland bird receptor. However, mallards do occasionally forage in upland areas adjacent to wetland areas. Consistent with the methodology presented in the *Site-Wide Risk Assessment Work Plan* (ARCADIS BBL, 2007h) the mallard will be evaluated as a potential receptor in OU-A because portions of OU-A are in relatively close proximity to wetlands (OU-E). Mallards forage primarily on grains, seeds, leaves, aquatic plants, grasses, and invertebrates; have a relatively small body size, and exposure parameters are readily available. The diet of the mallard will be assumed to be 70% plant material and 30% insects.
- **Invertivorous birds** – killdeer (*Charadrius vociferous*): The killdeer was observed onsite during plant and wildlife surveys conducted to support the biological assessment prepared by WRA (2005; ARCADIS BBL, 2007h). Killdeer forage primarily on animal matter (mostly insects), have a relatively small body size (which makes them a conservative surrogate for other invertivorous birds), and exposure parameters are readily available. The diet of the killdeer will be assumed to be composed of 100% insects.
- **Carnivorous birds** – American kestrel (*Falco sparverius*): The American kestrel is a common raptor in open areas and woodlands of California and, because of its relatively smaller body size (compared to other raptors), is a conservative surrogate for other carnivorous birds. Exposure parameters are readily available for the American kestrel.
- **Herbivorous mammals** – mule deer (*Odocoileus hemionus*): Mule deer feed preferentially on new growth shrubs, forbs, and grasses that are abundant on

much of the terrestrial portion of the site and are common to the area. Other herbivorous mammals have been observed onsite (e.g., black-tailed deer), but exposure parameters are readily available for the mule deer.

- **Carnivorous mammals** – red fox (*Vulpes vulpes*): Because of its relatively small body size, the red fox is considered a conservative representative receptor for carnivorous mammals. Additionally, the fox has been observed onsite, and exposure parameters are readily available for the red fox.
- **Invertivorous mammals (and burrowing wildlife)** – ornate shrew (*Sorex ornatus*): The ornate shrew feeds primarily on insects and other invertebrates, is a common terrestrial inhabitant, and because of its burrowing habits can serve as a representative receptor for both invertivorous mammals and burrowing wildlife. Exposure parameters are readily available for the ornate shrew.

6.3.3.4 Risk Questions

To evaluate potential risk to the ecological receptor groups identified in Section 6.3.3, RQs were developed. The following list outlines the questions and how they will be addressed.

- RQ-1 – Are chemicals in OU-A environmental media present at concentrations greater than site-specific reference/background levels?

RQ-1 was completed independently of the ERA. As discussed in Section 3, the background evaluation compared site concentrations in a given media to reference/ambient or background concentration data, as appropriate. For soil, concentrations in site samples were compared to background concentrations of naturally occurring constituents, such as metals. Chemicals elevated as compared to reference/ambient or background concentrations were considered as COPCs.

- RQ-2 – Are COPCs in OU-A environmental media present at concentrations above conservative risk-based ecological screening levels protective of lower trophic-level ecological receptors?

RQ-2 was evaluated during Phase I (SLERA) by comparing the maximum reported concentration in a given media to conservative risk-based ecological screening levels (EcoSSL and Oak Ridge National Laboratory [ORNL], or other relevant phytotoxicity and soil invertebrate benchmarks for soils; and California Toxics Rule

and USEPA ambient water quality criteria, or other relevant water quality benchmarks for seep water).

- RQ-3 – Are COPCs in OU-A environmental media present at concentrations that pose an unacceptable risk to higher trophic-level ecological receptors?

RQ-3 was evaluated during Phase II (BERA) by comparing site and reference media and/or modeled dietary COPC exposure concentrations/doses to applicable and relevant toxicity values to calculate HQs based on the 95% UCL on the mean concentration.

- RQ-4 – Are COPCs in OU-A environmental media present at concentrations that pose an unacceptable risk to special status plant species?

RQ-4 was evaluated during Phase II (BERA) by comparing site soil concentrations to conservative risk-based ecological screening levels (i.e., EcoSSLs, ORNL phytotoxicity benchmarks) using both the 95% UCLs to assess overall exposure for local plant communities and maximum (and point-by-point) comparison, as necessary, in areas that currently contain and/or provide appropriate habitat for special status plants onsite (limited to bluff areas).

- RQ-5 – For COPC-receptor pairs for which the BERA indicates a potential risk, is the level of exposure indicated greater than ambient/background exposure?

RQ-5 was evaluated during Phase II (BERA) by comparing ecologically relevant exposure estimates (i.e., 95% UCL) to the upper-bound background concentration of naturally occurring constituents, such as metals and any non-naturally occurring chemicals that may be present from anthropogenic activities unrelated to historical operations/activities at the site (limited to dioxins/furans), to determine if incremental exposure is present.

6.3.3.5 Assessment Endpoints and Measurement Endpoints

To assess the RQs quantitatively, AEs will be used along with associated MEs. AEs are selected based on the ecological receptor groups and complete exposure pathways identified during the scoping assessment. The AEs are designed to identify the ecological values at the site that should be protected. The MEs are developed as a means of measuring potential ecological effects to AEs and determining whether any potential risk is associated with the COPC concentrations in each medium.

In general, AE selection must consider the ecosystem, communities, and species relevant to a specific site. As defined by the USEPA (1997c), AEs are formal expressions of the actual environmental values that are to be protected at a site. AEs are defined based on technical considerations, including the significance of exposure pathways, the presence of receptors, and a COPC's biotic transfer pathway. These characteristics are examined during the development of the problem formulation. The selection of AEs depends on:

- The chemicals present and their concentration
- Mechanisms of toxicity of the chemicals to different groups of organisms
- Ecologically relevant receptor groups that are potentially sensitive or highly exposed to the chemicals
- Potentially complete exposure pathways.

An ME is defined as a “measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint” and is a measure of biological effects (e.g., mortality, reproduction, and growth) (USEPA, 1997c). The AEs and associated MEs and decision rules for the OU-A ERA are summarized in Table 6-17.

6.3.4 Screening-Level Ecological Risk Assessment (Phase I)

The following sections describe the methodology and results of the SLERA for OU-A.

6.3.4.1 Exposure Assessment

The exposure assessment is used to develop estimates for receptor exposure to site COPCs. This includes defining EUs and calculating EPCs. EPCs are defined as the contaminant media concentrations a receptor may be exposed to. As discussed previously, because the northern and southern portions of OU-A are divided by Soldier Bay and OU-E and thus are geographically separate, and because they do contain different habitat types that could be utilized differently by ecological receptors, they were treated as separate EUs (defined as OU-A North and OU-A South). As such, EPCs were developed for these two portions of OU-A separately. The approach for selecting COPCs for the SLERA was described in Section 6.1. The approach for

developing SLERA exposure estimates for specific receptors is described in the sections below.

Screening-Level Direct Contact Exposure for Plants and Invertebrates

A screening-level risk evaluation for plants and invertebrates exposure to OU-A North and OU-A South soils was performed.

For soil, COPC concentrations were compared to conservative direct-contact phytotoxicity and invertebrate benchmarks. Exposure estimates for this SLERA step were based on the maximum detected contaminant concentrations in each EU separately.

Seep Water Screen for Potential Direct Contact Exposure of Offsite Aquatic Life

In seep water, all detected COIs were evaluated as COPCs and compared to conservative water quality criteria protective of aquatic life. Because seeps are considered isolated and migration between them by receptors is considered unlikely, each seep was evaluated independently, but results were grouped by whichever EU in which they occurred. Exposure estimates for this SLERA step were based on the maximum detected contaminant concentrations detected in each seep.

Screening-Level Food Web Exposure for Wildlife

The final step in the SLERA was the food-web analysis. Wildlife receptors may be exposed to site-related COPCs via direct exposures and via ingestion of contaminated prey. These wildlife receptors include herbivorous, invertivorous, and carnivorous birds and mammals.

Receptor Daily Dose Equation

To account for food-web exposures, a standard dose model was used to estimate COPC daily intake via ingestion, which is consistent with the equation provided in the USEPA's (1993) Wildlife EFH. The dose model uses the general equation as follows:

Equation 6-3:

$$Dose = \frac{SUF \times \{ IR_{food} [(C_{prey} \times Pd_{prey}) + (C_{invert} \times Pd_{invert}) + (C_{plant} \times Pd_{plant}) + (C_{media} \times Pd_{media})] + [IR_{water} \times C_{water}] \}}{BW}$$

Where:

Dose	=	estimated daily dose of COPC from ingestion (mg/kg body weight/day)
SUF	=	site use factor (unitless)
IR _{food}	=	amount of food ingested per day (kg [dry weight])/day
BW	=	body weight (kg)
C _{prey}	=	EPC of COPC in prey items (mg/kg dry weight)
Pd _{prey}	=	proportion of diet from prey items (unitless)
C _{invert}	=	EPC of COPC in invertebrate items (mg/kg dry weight)
Pd _{invert}	=	proportion of diet from invertebrate items (unitless)
C _{plant}	=	EPC of COPC in plant items (mg/kg dry weight)
Pd _{plant}	=	proportion of diet from plant items (unitless)
C _{media}	=	EPC of COPC in media (i.e., EPC in water [mg/L] or soil and sediment [mg/kg-dry weight])
Pd _{media}	=	proportion of diet from soil, sediment, or water (unitless)
IR _{water}	=	amount of drinking water ingested per day (L/day)
C _{water}	=	EPC of COPC in drinking water (mg/L)

The dose model inputs into Equation 6-3 are explained below, as applicable to the receptors and pathways evaluated for OU-A.

Species-Specific Exposure Parameters

The above model inputs, except for C_{prey} , C_{invert} , C_{plant} and C_{media} , are receptor-specific. Receptor-specific inputs are based on the USEPA's (1993) Wildlife EFH and the peer-reviewed literature. The USEPA-approved allometric models are used for developing some of the ingestion rates (USEPA, 1993). Selections were based on the available, ecologically relevant and conservative ingestion rates, foraging or home range, body weights, and dietary compositions. Exposure parameters are presented for each selected representative receptor species in Tables 6-18 through 6-25. For the SLERA, some default conservative inputs were used as inputs to the food-web model. Specifically, EPCs for each COPC were based on the maximum detected concentration for a given media (i.e., soil, sediment, or water) for the OU being assessed, and for site use factors (SUFs), a default value of one was used.

Derivation of Media and Tissue Concentrations

The exposure parameters, C_{prey} , C_{invert} , C_{plant} , and C_{media} , are environmental media concentrations, which were calculated for OU-A North and OU-A South separately. For the SLERA, C_{media} was the maximum concentration reported in the media of interest. C_{prey} , C_{invert} , and C_{plant} are the COPC tissue concentrations in potentially contaminated prey. For the SLERA, COPC concentrations were modeled via the maximum detected concentration in the relevant media (i.e., soil or seep water) and a conservative estimated uptake regression model or bioaccumulation factor (BAF) using the following equation:

Equation 6-4:

$$C_{tissue} = C_{media} \times BAF_{media-tissue}$$

Where:

- C_{tissue} = modeled COPC concentration in prey (plants, invertebrates, fish, small mammals)
- C_{media} = COPC EPC for relevant media (soil, sediment, surface water)

$BAF_{\text{media-tissue}}$ = the bioaccumulation factor between relevant media and tissue (prey, invertebrate, or plant); alternatively, a regression equation can be used

With the exception of site-specific BAFs and regressions based on field-collected plants and invertebrate tissue data for concentrations of dioxins/furans, the BAFs used were based on constituent-specific soil-to-plant, soil-to-soil invertebrate, and soil-to-small mammal relationships obtained from studies in government documents and the peer-reviewed literature (e.g., Sample et al., 1998a,b; 1999; Bechtel Jacobs Company LLC, 1998a,b; USEPA, 1995b). For both the site-specific evaluations for dioxins/furans and the literature bioaccumulation evaluations, log-linear regression models, where available and appropriate, were preferentially selected over BAFs because BAFs assume that uptake is constant across any soil concentration; whereas regression models take into account varying uptake with soil concentration.

Site-specific dioxin/furan tissue data, BAFs, and regressions are discussed in Appendix F. As discussed above, regressions were preferred when the data supported their development; otherwise BAFs were selected. Separate biota studies were conducted for OU-A North and OU-A South, and the regressions and BAFs used in exposure estimates were those for the appropriate EU.

Literature-based log-linear regressions and BAFs used in this ERA for COPCs other than dioxins/furans are presented in Appendix I.

Baseline Wildlife Food Web Exposure for Wildlife

To develop baseline food web exposure estimates for wildlife, species and site-specific SUFs were used, and 95%UCLs were used as media EPCs. Additionally “alternative” SUFs were evaluated to address the potential contribution of OU-A to cumulative spatial exposure across the entire site. As indicated by footnote “a” on Table 6-25, the Alternate SUF for the red fox reflects that exposure would not be expected to occur in OU-C or OU-B (which are expected to be largely developed in the future); therefore, maximal exposure would be expected to be 294 acres (the balance of the acreage of the entire site). Other Alternative SUFs are 1 because either the foraging ranges of the other terrestrial receptors (i.e., American kestrel and mule deer) or the home range during breeding, as in the case of the killdeer, is less than 294 acres.

6.3.4.2 Effects Assessment

The effects assessment identifies toxicological effects data (e.g., water quality criteria, soil phytotoxicity values, soil invertebrate toxicity values, and wildlife TRVs) that are used as benchmarks to compare to site COPC exposure concentrations or doses. In general, benchmarks were selected to be conservative estimators of potential toxic effects. For the SLERA, low toxicity values were selected that generally represent an exposure level below which there is high confidence in a finding of *de minimus* risk. This value is typically based on a no adverse effect level (NOAEL) or a 10th percentile of low effects data for non-lethal endpoints. The assessment of risks to populations of receptors using low toxicity values and TRVs can be considered conservative in nature. High benchmarks, which can generally be considered to represent an exposure level above which deleterious effects are expected, were also used in the BERA. Risk estimated based on high toxicity values and TRVs is more indicative of the potential for adverse effects.

Although in some cases the low and high benchmarks and/or toxicity reference values used are not based specifically on no-effect and/or bounded low-effect data, the values may still be used to identify environmental concentrations that are not of concern, or alternatively that may require further evaluation. For example, although ER-Ls and ER-Ms (which are not used herein) are based on the 10th and 50th percentile of selected laboratory-derive effects data, ER-Ls are commonly used as conservative screening levels (i.e., concentrations below which no effects are expected and therefore no additional investigation is warranted). NOAA states (in the document *Sediment Quality Guidelines Developed for the National Status and Trends Program*; www.ccma.nos.noaa.gov/publications/sqg.pdf): “The 10th percentile values were named the ‘Effects Range-Low’, indicative of concentrations below which adverse effects rarely occur.” Included in NOAA’s Screening Quick Reference Tables (SQuiRTs) is a similar statement: “Since the ERL is at the low end of a range of levels at which effects were observed in the studies compiled, it represents the value at which toxicity may begin to be observed in sensitive species.”²

² It is additionally important to remember that screening values such as ER-Ls and ER-Ms are generic, and they do not consider site-specific factors that may alter bioavailability and associated toxicity, and they reflect potential effects from multiple stressors as sediments used contained mixtures of contaminants.

It is recognized that decisions regarding when additional investigation and/or remedial action is necessary is ultimately a risk management decision made by risk managers, and the benchmarks, screening values, and toxicological reference values used in this ERA do not constitute “bright lines” for decisions making. They are instead considered as tools and used to support recommendations for risk managers.

Plant and Invertebrate Direct Contact Toxicity

COPC exposures to plants and invertebrates occur via direct contact or uptake associated with feeding. Direct contact was used for the effects assessment on these receptor types. The SLERA focused on low toxicity benchmarks. Direct contact ecological screening values for soil (plants and soil invertebrates) and water (invertebrate) are presented in Appendix I. Available EcoSSLs for plants and terrestrial invertebrates (USEPA, 2007c) were used preferentially for this comparison. Other sources of benchmarks include Efroymsen et al. (1997a,b) and others as noted in Appendix I. Data for seep water were compared to water quality criteria. Fresh water criteria values used preferentially in the SLERA consisted of, but were not limited to, California Toxics Rule values (Appendix I). The criteria presented in Appendix I are considered protective of aquatic life (see respective citations reported in Appendix I).

Food Web Toxicity Reference Values (for Wildlife)

COPC exposures to wildlife (herbivorous, invertivorous, carnivorous, and piscivorous birds and mammals) occur via ingestion of contaminated media and contaminated prey. As a result, COPC effects values are often reported as a dose concentration. Food-web TRVs are used to evaluate potential effects to wildlife and are defined as the dose of a particular COPC that is protective of a particular wildlife receptor. The SLERA focused on low TRVs.

The primary wildlife TRVs used are from the USEPA Region 9 Biological Technical Assistance Group (BTAG) TRVs (EFA West, 1998) provided in Appendix I. The following sources (listed in order of priority) were used to identify additional/alternative TRVs when a BTAG TRV was not available:

- ORNL toxicity benchmarks (Sample et al., 1996)
- USEPA's (2007) EcoSSLs.

Toxicity Assessment for Specific Classes of Chemicals

The potential cumulative effect of specific classes of chemicals was evaluated for PAHs and dioxins/furans. PAHs were evaluated individually and by summing the HQs calculated for individual PAHs. Total PAHs were separated into two classes based on molecular weight (i.e. low molecular weight [LMW] and high molecular weight [HMW] PAHs). Because the availability of individual PAH benchmarks is limited, B(a)P was used as a surrogate for HMW PAHs and naphthalene as a surrogate for LMW PAHs. Dioxins/furans were evaluated by applying WHO-2005 TEFs (Van den Berg et al., 2006) to individual congeners, summing the resulting values, and comparing the TCDD TEQ concentrations to the ORNL TRV for 2,3,7,8-TCDD. Other than these two chemical classes, cumulative effects of chemicals were not quantitatively evaluated.

Chemicals of Interest without Screening Values

Contaminants that do not have available risk-based screening criteria were retained as COPCs if detected, but were assessed qualitatively in the uncertainty assessment.

6.3.4.3 Risk Characterization

The HQ was the primary tool used to assess potential risks for a given COPC. For direct exposure, the HQ represents the ratio of estimated EPC to a medium-based toxicity benchmark (Equation 6-5). For food-web assessment, the HQ represents the ratio of an estimated daily dose to a wildlife TRV (Equation 6-6).

Equation 6-5:

$$HQ = \frac{EPC}{\text{Direct Contact Benchmark or EcoSSL}}$$

Equation 6-6:

$$HQ = \frac{Dose}{TRV}$$

Where:

- HQ = hazard quotient
- EPC = exposure point concentration in exposure media (mg/kg or µg/L)
- Dose = daily intake of a COPC via ingestion normalized by receptor body weight (mg/kg-day)
- TRV = toxicity reference value measured as an effects-level threshold concentration of COPC normalized by receptor body weight (mg/kg-day)

HQs were calculated for those COPCs that were not screened out by the SLERA. Proper interpretation of HQs is critical to the risk assessment process, as well as to risk management decision-making. Consistent with USEPA guidance (1997c), an HQ less than one suggests an “acceptable” level of risk. An HQ equal to or greater than one suggests a potential for adverse impacts.

For the SLERA, low benchmarks are based on chronic exposure NOAEL benchmarks. The low values represent a toxicological threshold below which there is high confidence in a finding of no risk and no observable adverse effects. An exceedance of these benchmarks does not necessarily indicate risk; rather, it only indicates that further evaluation is warranted.

The following sections describe the results of the SLERA based on exposure media and receptor.

Seep Water Exposure

Tables 6-26 and 6-27 summarize the risk results for direct contact with seep water, which are based on comparisons of seep water to ambient water quality criteria designed to be protective on an individual chemical basis in a receiving system (e.g., the ocean). These results are not intended to be used to assess overall (cumulative, additive, or synergistic) toxicity as many chemicals have different routes/sites of exposure and modes of action/toxicity mechanisms. The comparisons were conducted as a screening exercise to determine the potential significance of these sources from a fate and transport perspective. HQs were calculated using the maximum detected values for each seep independently and all detected COIs were evaluated. As shown in Tables 6-26 and 6-27, HQs for the COIs in the seeps in both OU-A North and OU-A South, respectively, are less than one. As on an individual chemical basis, seep water

meets applicable receiving system standards at the point of expression, and significant dilution is expected at the point of contact with the receiving system, these results indicate the potential for no risk and no observable adverse effects to offsite aquatic receptors associated with direct contact to seep water, and it is concluded that these seeps do constitute a significant source to offsite surface waters.

Plant Exposure to Soil

Tables 6-28 and 6-29 present the risk results for direct contact of plants with site soil for OU-A North and OU-A South, respectively. HQs were calculated using the maximum detected soil COPC concentrations from each EU (OU-A North and OU-A South) compared to conservative screening-level phytotoxicity benchmarks. Risk results for each EU are summarized below.

OU-A North:

- PAHs – Phenanthrene was the only individual PAH that presented an HQ greater than one (HQ = 3). Total LMW and total HMW PAHs (as expressed by summing the HQs of their respective individual constituents) were both greater than one (HQ = 4 and 2, respectively). The HQ for phenanthrene contributed approximately 75% of the total LMW PAH HQ.
- Metals – HQs greater than one were observed for chromium (HQ = 50), vanadium (HQ = 50), and zinc (HQ = 5). Of these metals, only the maximum detected value for chromium did not exceed the background level for fill.³

OU-A South:

- PAHs – Phenanthrene was the only individual PAH that presented an HQ greater than one (HQ = 2). Total LMW and total HMW PAHs were both greater than one (HQ = 3 and 2, respectively). The HQ for phenanthrene contributed approximately 66% of the total LMW PAH HQ.

³ Note that the background level for fill was used as a comparison because over 60% of samples within each EU were from fill.

- Metals – HQs greater than one were observed for barium (HQ = 3) chromium (HQ = 60), molybdenum (HQ = 2), nickel (HQ = 2), vanadium (HQ = 40), and zinc (HQ = 5). Of these metals, only the maximum detected value for chromium did not exceed the background level for fill.

The COPCs listed above show HQs greater than one, but this is not necessarily an indication of risk. These COPCs are assessed further in the BERA using more realistic estimates of COPC concentration in soil. The implications of SLERA exceedances are most useful in determining the location of potential hot spots that may present potential risk to special status plants that may be located within such hot spots. Hot spots are discussed and their implications are examined further in the BERA.

Invertebrate Exposure to Soil

Tables 6-28 and 6-29 present the risk results from the direct contact of invertebrates with site soil for OU-A North and OU-A South, respectively. HQs were calculated using the maximum detected soil COPC concentrations from each EU compared to conservative screening-level invertebrate benchmarks. Risk results for each EU are summarized below.

OU-A North:

- PAHs – Total HMW PAHs was the only measure of PAHs in soil that showed an HQ greater than one (HQ = 2). No individual PAH contributed more than 25% of the total HMW PAH HQ.
- Metals – HQs greater than one were observed for chromium (HQ = 100), mercury (HQ = 2), and vanadium (HQ = 100). Of these metals, only the maximum detected value for chromium did not exceed the background level for fill.

OU-A South:

- VOCs – Toluene was the only VOC that presented an HQ greater than one. The exceedance was low (HQ = 2).
- PAHs – Total HMW PAHs was the only measure of PAHs in soil that showed an HQ greater than one (HQ = 2). The HQs from benzo(b)fluoranthene and chrysene were the two primary contributors, each contributing approximately 25% of the total HMW PAH HQ.

- Metals – HQs greater than one were observed for barium (HQ = 4), chromium (HQ = 200), mercury (HQ = 2), and vanadium (HQ = 80). Of these metals, only the maximum detected values for barium and chromium did not exceed the background levels for fill.

The COPCs listed above show HQs greater than one, but this is not necessarily an indication of risk. These COPCs are assessed further in the BERA using more realistic estimates of COPC concentrations in soil.

Avian Wildlife Exposure to Soil

Tables 6-28 and 6-29 present the food web model risk results for avian receptors in OU-A North and OU-A South, respectively. HQs were calculated using the maximum detected soil COPC concentrations from each OU, an SUF of one, and conservative TRVs (generally based on NOAEL toxicity values). Risk results for each OU are summarized below.

OU-A North:

- Metals – Metals were the only COPC class that displayed HQs greater than one in OU-A North. The invertivorous bird (killdeer) was the most sensitive species for all metals. HQs ranged in magnitude from 3 to 900 as follows: cadmium = 50, chromium = 5, copper = 3, lead = 900, mercury = 5, nickel = 8, and zinc = 6. Of these metals, only the maximum detected value for chromium did not exceed the background level for fill.

OU-A South:

- Dioxins/furans – Only the American kestrel showed an HQ greater than one in OU-A South (HQ = 4). This is based on the maximum avian TCDD TEQs found in OU-A (118 pg/g).
- Metals – The invertivorous bird (killdeer) was the most sensitive species for all metals. HQs ranged in magnitude from 3 to 800 as follows: barium = 3, chromium = 6, copper = 4, lead = 800, mercury = 3, nickel = 10, and zinc = 7. Of these metals, only the maximum detected values for barium and chromium did not exceed the background levels for fill.

The COPCs listed above show HQs greater than one, but this is not necessarily an indication of risk. These COPCs are assessed further in the BERA using more realistic estimates of COPC concentrations in soil, more representative foraging ranges, and a range of TRVs.

Mammalian Wildlife Exposure to Soil

Tables 6-28 and 6-29 present the food web model risk results for mammal receptors in OU-A North and OU-A South, respectively. HQs were calculated using the maximum detected soil COPC concentrations from each EU, an SUF of one, and conservative TRVs (generally based on NOAEL toxicity values). Risk results for each EU are summarized below.

OU-A North:

- Dioxins/furans – Only the red fox showed an HQ greater than one in OU-A North (HQ = 5). This was based on the maximum TCDD TEQs found in OU-A North (52 pg/g).
- Metals – Two metals (cadmium and nickel) had HQs greater than one in OU-A North (7 and 8 respectively). The invertivorous mammal (ornate shrew) was the most sensitive species for all metals. No difference in HQ was observed for shrew exposure based on the soil depth interval (0 to 0.5 foot bgs and 0 to 6 feet bgs). The maximum detected value for both cadmium and nickel exceeded the background levels for fill.

OU-A South:

- Dioxins/furans – Only the red fox showed an HQ greater than one in OU-A South (HQ = 4). This was based on the maximum TCDD TEQs found in OU-A North (41 pg/g).
- Metals – Five metals (barium, copper, nickel, vanadium, and zinc) had HQs greater than one in OU-A North. The invertivorous mammal (ornate shrew) was the most sensitive species for all metals, with the exception of barium. The 0- to 6-foot bgs depth interval exhibited higher HQs than the 0- to 0.5-foot bgs interval for the shrew. HQs for the shrew at the 0- to 6-foot bgs depth interval were copper = 2, nickel = 40, vanadium = 2, and zinc = 2. Barium had an HQ of 2 for the mule deer (using the 0- to 0.5-foot bgs interval). The maximum detected value for four of five

of these metals exceeded the background levels for fill; barium had a maximum detected concentration below the fill background level and, thus, is not of further concern. Only nickel had site-related HQs greater than one in the 0- to 0.5-foot bgs depth interval and, thus, is the only metal that could show potential risk to non-burrowing mammals in OU-A South.

The COPCs listed above show HQs greater than one, but this is not necessarily an indication of risk. These COPCs are assessed further in the BERA using more realistic estimates of COPC concentrations in soil, more representative foraging ranges, and a range of TRVs.

6.3.5 Baseline Ecological Risk Assessment (Phase II)

The BERA was conducted in the same manner as the SLERA except that exposures and HQs were estimated incorporating 95% UCLs as EPCs (or maximum detected concentrations if the calculated 95% UCL was greater than the maximum detected concentration), and using receptor- and exposure area-specific SUFs and “high” TRVs. The basis of the high TRVs varies depending on source. BTAG-high TRVs represent the mid-point of a variety of adverse effects, and therefore are not necessarily representative of a low adverse effect level (LOAEL). ORNL TRVs, however, are based on LOAEL values. It is also important to note that the EPCs used in the BERA incorporate an assumption that higher concentrations of some COPCs will be removed via the remediation of the PRAs described in Sections 5 and 6. In other words, the conclusions contained in this report apply to a post-remedy condition assuming that the PRAs are addressed and that “clean” fill material is used to replace soil that currently occupies the PRAs. The results of the BERA calculations for plants, invertebrates, birds, and mammals for the OU-A North and OU-A South EUs are presented in Tables 6-30 and 6-31, respectively, and are discussed below.

6.3.5.1 *Plants*

Tables 6-30 and 6-31 present results of BERA calculations, including comparisons of 95% UCL EPCs for soil to conservative phytotoxicity screening benchmarks protective of plants. In OU-A North, exceedances (i.e., HQ greater than one) were limited to chromium (HQ = 30) and vanadium (HQ = 20). Exceedances for chromium (HQ = 30) and vanadium (HQ = 20) in OU-A South were also shown, and the EPC for zinc additionally resulted in an HQ greater than one (HQ = 2) in OU-A South. The soil EPCs (95% UCLs) in OU-A North and OU-A South for chromium, vanadium, and zinc were all less than their respective background levels, indicating that plant exposure in OU-A

to these metals does not represent incremental exposure, and therefore, does not result in incremental risk compared to ambient conditions. The source of the phytotoxicity benchmarks (Efroymson et al., 1997a,b) states that if the chemical concentration or its detection limit falls below the proposed benchmark, the chemical may be eliminated from further study unless public concern or ancillary evidence suggests that it should be retained, and additionally recognizes that if a benchmark is exceeded by background soil concentrations, it is generally safe to assume that the benchmark is a poor measure of risk to the plant community.

As discussed in Section 6.3.3.1, plants in OU-A include special status members (i.e., Blasdale's bent grass, Mendocino coast Indian paintbrush, and short leaved evax). Because protection of these plants is often considered at a different level than non-special status plants (i.e., at the level of the individual), the use of a 95% UCL exposure estimate alone may not provide sufficient information to judge risk protection on an individual level (i.e., location-by-location basis). To assess the potential for risk to the individual, the coincidence of soil sampling locations where concentrations of chromium, vanadium, and zinc greater than background, and phytotoxicity benchmarks was plotted (see Figure 6-5 and 6-6). As indicated on Figure 6-5 and 6-6, elevated concentrations of these three metals (i.e., concentrations greater than background) do not coincide with the current distribution of these special status plants in OU-A. It is important to consider that, with the exception of location OUA-TP-089 (which has been shown to be very limited in extent; see further discussion below), concentrations of chromium, zinc, and vanadium are only slightly elevated relative to background (concentrations of these metals are more significantly elevated at OUA-TP-089). It is not expected that the distribution of Mendocino coast Indian paintbrush and short-leaved evax would in the future coincide with elevated concentrations (given the potential range of future restoration and/or re-vegetation plans) as these plants grow along the tops of bluffs near the bluff edge and on cliff faces where these metal concentrations are not elevated. Blasdale's bent grass, however, could have a wider distribution in the future.

As indicated by Figures 6-5 and 6-6, some areas have concentrations of metals above conservative phytotoxicity benchmarks and if restoration or redevelopment plans include expanding the distribution of Blasdale's bent grass into eastern portions of OU-A, these plant species could occur in those areas. However, as also noted above, the phytotoxicity benchmarks used also fall well below the upper-background levels. Therefore, the risks predicted in this assessment may be greatly overestimated (as discussed further in the uncertainty analysis).

6.3.5.2 Invertebrates

As presented in Tables 6-30 and 6-31, 95% UCLs from OU-A North and OU-A South exceeded screening-level soil benchmarks (i.e., HQ greater than one) protective of terrestrial invertebrates for chromium (HQ = 80) and vanadium (HQ = 40). The 95% UCLs for both of these metals, however, are less than their respective background levels. Although no special status members of the terrestrial invertebrate community are known to exist in OU-A (precluding the need for consideration of localized risk associated with potential “hot spots”), soil results were reviewed at the request of the regulatory agencies to identify any areas where potential reductions in localized populations could impact the local ecosystem (e.g., based on impacts to the prey base for larger wildlife).

Table A-1 presents the location-by-location soil screening results for metals in OU-A. Although Table A-1 does not present risk screening for soil invertebrates, the soil screening levels for chromium (0.4 mg/kg) and vanadium (1 mg/kg) are lower than their respective background levels (chromium: 60 mg/kg, vanadium: 90 mg/kg); thus, exceedances of background levels for these metals are relevant for discussing potential localized impact to invertebrates.

As indicated on Table A-1 and Figure 6-6, soil concentrations of chromium exceeded background levels developed for fill at only three locations (OUA-HA-037 [62 mg/kg], OUA-TP-080 [64 mg/kg], and OUA-TP-089 [330 mg/kg]). Similar to arsenic, these locations are not adjacent to each other, they are each surrounded or “bounded” by other sampling locations with chromium concentrations consistent with background conditions, and chromium was significantly elevated (with respect to background) at only one of these locations (OUA-TP-089). It is not expected that concentrations of chromium in OU-A would result in reductions in localized populations of invertebrates. As indicated on Table A-1 and Figure 6-6, soil concentrations of vanadium exceeded background levels developed for fill at only three locations (OUA-TP-031 [99 mg/kg], OUA-TP-034 [94 mg/kg], and OUA-TP-089 [260mg/kg]). These locations are not adjacent to each other, they are each surrounded or “bounded” by other sampling locations with vanadium concentrations consistent with background conditions, and vanadium was significantly elevated (with respect to background) at only one of these locations (OUA-TP-089). It is not expected that concentrations of vanadium in OU-A would result in reductions in localized populations of invertebrates.

Given that vanadium and chromium both exceeded their respective background levels at a single location (OUA-TP-089), and this location is bounded by OUA-HA-043 and

OUA-HA-042 (both of which have concentrations of chromium and vanadium that are significantly lower than the background thresholds for fill⁴), it is not expected that concentrations of vanadium and chromium (in combination) in OU-A would result in reductions in localized populations of invertebrates.

6.3.5.3 Avian Wildlife

Tables 6-30 and 6-31 present baseline HQs for avian receptors evaluated for OU-A North and OU-A South (i.e., American kestrel, California quail, killdeer, and mallard). In OU-A North, estimated daily doses exceeded low TRVs (i.e., HQs greater than one) for cadmium (HQ = 20 for both kestrel and killdeer) and lead (HQ = 30 for kestrel and killdeer, and HQ = 10 for quail and mallard). In OU-A South, estimated daily doses exceeded low TRVs (i.e., HQs greater than one) for lead only (HQ = 10 for kestrel, quail, and killdeer, and HQ = 5 for mallard).

Because low TRVs are generally considered to represent daily exposure levels below which effects are not likely, but do not represent daily exposure levels above which effects are expected, low TRV HQs less than or equal to one are not considered to indicate acceptable levels of risk. This is particularly applicable for BTAG TRV-low benchmarks, which according to the source document for these TRVs (DTSC, 2001), represent a dose which “would not be expected to produce an adverse effect and is protective of an individual or population or organisms.”

Alternatively, high TRVs are considered to represent daily exposure levels above which effects are expected. High TRV HQs for all COPCs and all avian receptors were less than one, indicating that adverse effects (consistent with unacceptable risk) on populations of receptors are not expected. It is additionally important to consider that soil EPCs (95% UCLs) for these metals were below site-specific background levels (for fill) indicating that site-associated exposures (and therefore risks) are not greater than ambient conditions.

⁴ Chromium concentrations in soil at OUA-HA-042 and OUA-HA-043 range from 20 to 37 mg/kg, and vanadium concentrations in soil at OUA-HA-042 and OUA-HA-043 range from 28 to 61 mg/kg. Background levels for chromium and vanadium in fill are 60 mg/kg and 90 mg/kg, respectively.

Although terrestrial avian receptors evaluated do not include special status species requiring protection at the individual level, the receptors selected include a small ranging bird (i.e., the California quail) that may integrate exposure over areas smaller than OU-A. To address this potential issue, screening-level risk results were reviewed to identify compounds that may pose risk on a scale smaller than the entire OU (as baseline risk exposure estimates were developed based on a 95%UCL calculation considering all relevant data within OU-A).

As indicated on Tables 6-28 and 6-29, only lead was identified as a potential risk driver (screening level OU-A North HQ=60, OU-A South HQ=50) for the quail using an exposure estimate based on the maximum detected concentration in each area. Based on the BTAG avian lead TRV, a protective soil concentration for the quail (using screening-level exposure assumptions [i.e., an SUF of 1]) would be less than 5 mg/kg, approximately 5 times less than the background estimate of 25 mg/kg for lead⁵. Given that the use of the BTAG avian TRV for lead would drive a protective level much lower than background for lead, it is appropriate to use the background concentration for lead to evaluate the potential for incremental (i.e., greater than risk associated with ambient exposure) risk on a smaller spatial scale. As discussed, the site-specific lead background level for fill lithology soils is currently under discussion. The final agreed-upon value is expected to be at or above 25 mg/kg and (potentially up to 69 mg/kg). Although for this RI a value of 25 mg/kg has been used as an interim background level, the discussion of incremental exposure and risk (i.e., greater than ambient/background) includes discussion of the potential range for background lead concentrations in soil (i.e., 25 mg/kg to 69 mg/kg).

Based on the data presented on Table A-1, soil concentrations of lead exceeded the potential upper end of the background range for lead in fill (69 mg/kg) at seven locations (OUA-HA-029 [85 mg/kg], OUA-HA-069 [70 mg/kg], OUA-HA-20 [130 mg/kg], OUA-TP-072 [74 mg/kg], OUA-TP-089 [170 mg/kg], OUA-HA-012 [110 mg/kg], OUA-HA-010 [79 mg/kg]) that will not be addressed by remediation planned for designated PRA areas (e.g., locations OUA-HA-027, OUA-HA-046, OUA-HA-047, OUA-HA-048, OUA-HA-068, OUA-TP-019, OUA-DP-014, and OUA-DP-016 will be addressed by

⁵ The site-specific lead background level for fill lithology soils is currently under discussion. The final agreed-upon value is expected to be at or above 25 mg/kg. Therefore, for this RI, a value of 25 mg/kg has been used as an interim background level.

planned remediation). As discussed in Section 5.3.4, the “step-out” samples were collected to bound the location with the highest metals concentrations (OUA-TP-089), and metals (including lead) were detected at the step-out locations at concentrations below background levels. Regarding elevated concentrations of metals at location OUA-TP-089, it is also important to note that with the exception of barium, all metals detected above background levels at this location were detected in the 1 to 1.5 bgs interval (all results from the 0 to 0.5 bgs as well as the deeper interval were consistent with background metals concentration).

Additionally, as indicated on Table A-1, lead exceeds the potential lower end of the background range for lead in fill (i.e., 25 mg/kg) in the top two feet of soil (the depth interval relevant for avian wildlife exposure) at a number of additional locations that will not be addressed by the currently proposed PRAs. These locations include:

OU-A North

- OUA-HA-016 (39 mg/kg)
- OUA-HA-028 (32 mg/kg)
- P1-7 (34 mg/kg)
- OUA-HA-017 (40 mg/kg)
- OUA-HA-022 (33 mg/kg)
- OUA-TP-016 (35 and 52 mg/kg)

OU-A South

- OUA-DP-002 (32 mg/kg)
- OUA-HA-042 (32 mg/kg)
- OUA-TP-087 (47 mg/kg)
- OUA-DP-005 (31 mg/kg)

- OUA-DP-007 (33 mg/kg)
- OUA-DP-008 (57 mg/kg)
- OUA-DP-010 (28 mg/kg).

The locations discussed above (i.e., areas where metals were detected above the potential background range for lead and risk screening levels, but are not included in PRAs) because they: 1) are not clustered in one area and are generally surrounded or “bounded” by other sampling locations with lead concentrations consistent with background conditions; 2) include only three locations (OUA-HA-20, OUA-TP-089, and OUA-HA-012) where lead was significantly elevated with respect to background; and 3) do not result in a 95% UCL for lead for OU-A North (i.e., 24 mg/kg) or OU-A South (25 mg/kg) greater than the low end of the range of background estimate for lead in fill (25 mg/kg). Therefore, it is not expected that concentrations of lead in OU-A will impact the population of California quail that may forage in OU-A.

6.3.5.4 Mammalian Wildlife

Tables 6-30 and 6-31 present baseline HQs for mammalian receptors (i.e., mule deer, red fox, and ornate shrew) evaluated for OU-A North and OU-A South, respectively. In both OU-A North and OU-A South, estimated daily doses exceeded low TRVs (i.e., HQs greater than one) for the ornate shrew only (all HQs were equal to or less than one for the red fox and the mule deer). Baseline exposures for the ornate shrew were estimated using both the 0- to 0.5-foot and 0- to 6-foot bgs soil depth intervals to develop EPCs (95% UCLs), consistent with the shrew’s exposure to surface soils (as a representative small mammal) and subsurface soils (as a representative burrowing mammal). EPCs and associated risks were similar for these depth intervals, but were slightly higher using the surface interval (0 to 0.5 foot bgs). Estimated daily doses (based on the 0- to 0.5-foot bgs depth interval) exceeded the low TRVs (i.e., HQs greater than one) in OU-A North for cadmium (HQ = 2) and nickel (HQ = 6), and in OU-A South for nickel only (HQ = 5).

As previously discussed, because low TRVs are generally considered to represent daily exposure levels below which effects are not likely but do not represent daily exposure levels above which effects are expected, low TRV HQs less than or equal to one are considered to indicate acceptable levels of risk. This is particularly applicable for BTAG TRV-low benchmarks, which according to the source document for these

TRVs (DTSC, 2001), represent a dose which “would not be expected to produce an adverse effect and is protective of an individual or population or organisms.”

High TRV HQs for all COPCs and all mammalian receptors (including the ornate shrew) were less than one, indicating that adverse effects (consistent with unacceptable risk) on populations of receptors are not expected. It is additionally important to consider that soil EPCs (95% UCLs) for cadmium and nickel were below site-specific background levels (for fill) indicating that site-associated exposures (and therefore risks) are not greater than ambient conditions.

Although the terrestrial mammalian receptors evaluated do not include special status species requiring protection at the individual level, the receptors selected include a small ranging mammal (i.e., the ornate shrew) that may integrate exposure over areas smaller than OU-A. To address this potential issue, screening-level risk results were reviewed to identify compounds that may pose risk on a scale smaller than the entire OU (as baseline risk exposure estimates were developed based on a 95%UCL calculation considering all relevant data within OU-A).

As indicated on Tables 6-28 and 6-29, only cadmium (OU-A North and South) and nickel (OU-A North only) was identified as a potential risk driver for the shrew using exposure estimates based on the maximum detected concentration in each area. Based on the low TRV, a protective soil concentration for the shrew (using screening-level exposure assumptions [i.e., an SUF of 1]) would be less than 1 mg/kg for cadmium and less than 10 mg/kg for nickel, which is lower than the established background levels for these metals (background levels for fill for cadmium and nickel are 2.8 and 41 mg/kg respectively). Given that risk-based protective concentrations would be much lower than background levels for these metals, it is appropriate to use background concentrations to evaluate the potential for incremental (i.e., greater than risk associated with ambient exposure) risk on a smaller spatial scale. Based on the comparisons presented on Table A-1, soil concentrations of cadmium exceeded background levels developed for fill at only three locations (OUA-HA-20 [3.2 mg/kg], P1-12 [2.9 mg/kg], and P1-14 [3.1 mg/kg]) that will not be addressed by remediation planned for designated PRA areas.

As the locations discussed above (i.e., areas where metals were detected above background and risk screening levels, but are not included in PRAs) are not clustered in one area and are generally surrounded or “bounded” by other sampling locations with cadmium concentrations consistent with background conditions, and cadmium was not significantly elevated (with respect to background) at any of these three

locations, it is not expected that concentrations of cadmium in OU-A will impact the population of shrew that may forage in OU-A considering small-scale or “hot spot” exposure. The same conclusion applies to nickel in OU-A North where, outside of defined PRA areas, only three locations (OUA-HA-32 [42 mg/kg], OU-A-TP-32 [43 mg/kg], and OUA-P1-15 [42 mg/kg]) had nickel concentrations slightly in excess of background for nickel (41 mg/kg). Remaining samples with concentrations greater than background for nickel in fill were all located in the PRAs (HA-048, P1-15, TP008, TP018, TP019, and P3-1).

6.3.5.5 Evaluation of Potential Cumulative Spatial Exposure

As discussed in the exposure assessment section (Section 6.3.4.1), the development of cumulative exposures for wide-ranging wildlife receptors that may be exposed across multiple OUs (including OU-A) cannot be conducted due to the schedule constraints associated with the completion of the OU-A risk assessment. To address risks associated with potential cumulative spatial exposures for wide-ranging receptors (or more specifically to assess the potential contribution of OU-A to cumulative spatial exposure and risk for wide-ranging receptors), this ERA includes an assessment of “alternative” conservative SUFs (e.g., HQ less than one) in the baseline scenario. Receptor-specific results (i.e., HQs) provide risk results that are conservatively protective of wide-ranging receptors and indicate that additional risk management steps may be needed in OUs other than OU-A in the event unacceptable risks are discovered for wide-ranging receptors in the future when cumulative exposure estimates can be calculated. For OU-A, alternative risk calculations were conducted for four receptors (two birds and two mammals) with large foraging ranges relative to the size of OU-A. Tables 6-32 and 6-33 present the results of the alternative exposure scenarios evaluated for OU-A North and OU-A South, respectively.

In OU-A North, estimated daily doses for wide-ranging birds (i.e., kestrel and killdeer) exceeded low TRVs (i.e., HQs greater than one) for a number of metals. For the kestrel, alternative HQs greater than one were calculated for cadmium (HQ = 5), lead (HQ = 100), and nickel (HQ = 2). For the killdeer, alternative HQs greater than one were calculated for cadmium (HQ = 10), chromium (HQ = 3), copper (HQ = 2), lead (HQ = 200), nickel (HQ = 7), and zinc (HQ = 4).

As previously discussed, HQs greater than one based on low TRVs are not considered to indicate unacceptable risk. High TRV alternative HQs for all COPCs for kestrel and killdeer were less than one, indicating that adverse effects (consistent with unacceptable risk) on populations of receptors are not expected, and OU-A is not

contributing to cumulative spatial exposure across multiple OUs resulting in unacceptable ecological risk. It is additionally important to consider that soil EPCs (95% UCLs) for cadmium and nickel were below site-specific background levels (for fill) indicating that site-associated exposures (and therefore risks) are not greater than ambient conditions.

The results for mammals (i.e., mule deer and red fox) indicate that OU-A is not contributing to cumulative spatial exposure across multiple OUs resulting in unacceptable ecological risk. All high and low TRV HQs for all COPCs and both wide ranging mammalian receptors are less than one.

6.3.6 Evaluation of Uncertainty

An understanding of the underlying uncertainties inherent in the data, inputs, models, and conclusions of the ERA is a critical aspect of a risk-based decision-making process. Identifying the sources and implications of the major uncertainties is crucial to the appropriate interpretation of ERA results. The significant uncertainties associated with developing exposure estimates, and selecting, applying, and interpreting ecological effects data to develop risk estimates are discussed in the following sections.

6.3.6.1 *Uncertainty Associated with Exposure Estimates*

All of the exposure estimates used in this ERA were selected to be conservative estimators of potential exposure. Exposure to plants and invertebrates is based on direct exposure to site media. For these EPCs, the Tier 2 exposure estimate is the 95% UCL. In addition, each AE was assessed on an individual point basis. For the upper trophic-level wildlife receptors (i.e., birds and mammals), there are two components to the exposure estimates used in this ERA. The first component is the EPC for each site media as described above. The second component of the exposure estimate is the model used to estimate a daily dose to the receptor based on the media EPCs. The conservatism and uncertainties associated with each of these elements is discussed below.

Media Exposure Point Concentrations

The use of the 95% UCL to estimate exposure may be an overestimate of actual site-associated exposure in some cases. The 95% UCL defines the upper range of the interval in which the mean may occur (with 95% degree of confidence) and as such is

a conservative assessment of the EPC. The 95% UCL can be dramatically higher than the mean and in some cases higher than the maximum if the variability within the dataset is high. When the 95% UCL exceeds the maximum, the EPC defaults to the maximum detected concentration. Thus, the 95% UCL or maximum may over estimate exposure to these COPCs.

Estimates of Food Web Exposure

The estimates of food-web exposure used in this ERA are based on a modeled daily dose to each receptor. This model includes receptor-specific exposure parameters that were selected from the available literature. Because the parameters used to estimate exposure through the food web have not been empirically measured, conservative assumptions were made that could result in an overestimate of exposure and risks. The dose-calculations model wildlife exposure through diet to site-related COPCs. With the exception of dioxin/furans in plants and invertebrates, the model uses the media EPCs discussed above along with a literature-derived BAFs to determine COPC concentrations in the prey items of each receptor. In addition, the model includes specific biological parameters for the receptor (body weight, daily ingestion rate, and dietary composition), and the exposure frequency (SUF). Each of these inputs has varying degrees of uncertainty, which are discussed in the following sections.

Concentrations in Tissue (BAFs)

With the exception of dioxin/furans in plants and invertebrates, site-specific tissue data for prey items were not collected. Consequently, COPC concentrations in vegetation, invertebrate, and vertebrate prey items were modeled using log-linear regressions and literature-derived BAFs. The use of regressions and BAFs in general introduces uncertainty into the dose estimation, as these values may or may not accurately represent site-specific concentrations in these media. Site-specific parameters such as soil organic carbon, pH, grain size, and temperature can all affect uptake. Thus, using a regression or BAF based on non-site-specific studies adds uncertainty to the evaluation. In general, literature-derived BAFs that are based on upper percentiles of a large dataset are conservative and often over estimate food item concentrations of chemicals resulting in an overestimate of exposure. However, regression and BAFs developed based on single studies or limited data may over or under estimate exposure.

Biological Exposure Parameters

The biological parameters included in the dose model for the food web include receptor ingestion rate, body weight, and dietary composition. These parameters were selected for each receptor from the available literature or calculated using allometric equations. Individuals within a population vary in several life history and behavioral traits. This variation can impact the output of the dose models. Body weights vary widely, and lower body weights are generally associated with higher calculated doses. However, the ingestion rate that corresponds with a high body weight will usually be higher as well, making this assumption false in some cases. Body weights and ingestion rates were chosen based on an ecologically relevant combination that would yield a conservative dose. Thus, these assumptions may overestimate exposure for some individuals in the population.

The percent diet composition and foraging behavior of the receptors were taken from published literature when available. The dietary composition, however, will vary depending on season and availability of preferred food sources. For most receptors, assumptions regarding dietary composition were made to maximize potential exposure for the feeding guild/trophic group the receptor represents. For example, the percent vegetation in the killdeer diet was assumed to be 100% invertivorous because the killdeer represents invertivorous feeding guild for birds. These assumptions may over- or underestimate exposure because of differences in actual feeding behaviors throughout the year and differences in uptake for various prey items and COPCs. However, as all trophic groups and feeding guilds were evaluated using the same assumption, the worse-case exposure scenario is captured in the assessment.

Actual Site Use by Ecological Receptors

The spatial analysis included as part of the Potential Cumulative Spatial Exposure risk characterization (Section 6.3.5.5) assumed an SUF of one for wide-ranging receptors that normally would have an SUF less than one. An SUF of one assumes that a receptor will forage at a particular location 100% of the time. This assumption can overstate the potential for risk at a particular location in cases where the surrounding concentrations are below the individual point value. For example, the use of an SUF of one for the spatial analysis of mercury exposure to the American kestrel may be overestimated by this approach, because areas of potential unacceptable risk are isolated and surrounded by areas of acceptable risk.

6.3.6.2 *Uncertainty Associated with Effects Data*

The following section describes uncertainties associated with toxicological benchmarks used in the ERA.

Quantity and Quality of Toxicity Data Used to Derive the Toxicity Reference Values

Uncertainties are associated with the quantity and variable quality of literature-derived toxicity data. To reduce the uncertainties in the toxicity dataset, most TRVs were generated from three widely accepted sources: BTAG (DTSC, 2001), USEPA's EcoSSL documents (USEPA, 2007c), and ORNL (Sample et al., 1996). It is recognized, however, that new toxicity data are generated every year, and not all of the relevant information may be included in the sources used for this ERA. In addition, TRVs for the same chemical can vary significantly among these sources. For example, the avian NOAEL for lead in the EcoSSL is 1.63 mg/kg-day, whereas the BTAG avian NOAEL (used in this risk assessment) is 0.014 mg/kg-day. Risk could potentially be over- or underestimated depending on the appropriateness of the TRV selected.

Uncertainty Associated With Determining a Toxicity Reference Value

The majority of the evaluated toxicity data were derived from laboratory studies that were conducted in settings that do not mimic true field conditions. Laboratory studies typically control various factors in order to isolate one parameter in particular. Although such controlled experiments result in a more valid interpretation of the isolated parameters or relationship, uncertainty is associated with assuming laboratory exposure conditions are equivalent to in-field exposure conditions. Exposure duration and toxicity characterization are two parameters that exemplify the difficulty in translating literature-derived data to data representing the exposure conditions for receptors at Fort Bragg. In development of TRVs, the use of chronic data is preferred. Available toxicological data were not always associated with chronic exposure durations. Therefore, uncertainties were introduced in extrapolating nonchronic test results to chronic receptor toxicity values. These uncertainties were partially handled through the application of uncertainty factors in the derivation of low TRVs.

Uncertainty is associated with the extrapolation of literature-derived toxicity endpoints (especially laboratory-based studies) to equivalent endpoints for receptors at Fort Bragg because of discrepancies in exposure conditions. For example, the stressors affecting a receptor exposed to COPCs in the wild can be very different than those

affecting an organism exposed in a laboratory setting. However, the direction, magnitude, and effect of this uncertainty are not known.

Magnitude of Difference between Low Toxicity Reference Values and High Toxicity Reference Values

Low TRVs derived by the BTAG, USEPA EcoSSL, and ORNL process represent a no-effect level, whereas the high TRVs represent the mid-range of effects levels found in the literature. There is a critical point on the dose-response curve at which effects will first be seen, but that dose is not always known. The difference between the low and high TRVs is typically an order of magnitude, and HQs between 1 and 10 give an indication of how close the dose may be to the no-effect or low-effects levels represented by the TRVs. When the difference between the low and high TRV for a COPC is very great, there is a high degree of uncertainty regarding where effects may first be seen.

The difference between the low and high TRVs is greater than two orders of magnitude for some COPCs, such as avian TRVs for cadmium and lead and mammalian TRVs for cadmium and nickel. A large difference in the high and low TRV for a COPC increases the uncertainty of risk conclusions based on the magnitude of the low benchmark HQ because it is unknown whether the dose estimated is approaching where first-effects may be found. An extreme case is lead, for which the avian high TRV is 625 times the avian low TRV. The SLERA showed high lead HQ values for avian receptors. Such a large difference between the low and high BTAG avian TRVs for lead and concerns about lead bioavailability and toxicity make it extremely difficult to accurately assess risk from lead in OU-A.

Use of Surrogate Toxicity Reference Values for Individual and Summed Constituents of Potential Concern

The mammalian low TRVs for B(a)P and naphthalene were used as surrogates for other individual HMW and LMW PAHs respectively, as well as for the summed HMW and LMW PAHs, respectively. Risk from individual components or sums that was estimated using a TRV for a surrogate chemical or mixture may be over or under estimated, depending on how the toxicity of the individual component relates to the mixture. In the case of PCBs, uncertainty in the risk estimates arises from the relationship of the toxicity of the congener mixture (the particular Aroclor) used in the toxicological study to the toxicity of the mixture present at the site.

Specific Uncertainties Associated with Phytotoxicity Benchmarks

The risk to plants from direct contact with soils was evaluated by comparing soil COPC concentrations against conservative plant benchmarks primarily from EcoSSLs and from ORNL, as well as other applicable sources. Soil with chemical concentrations that exceed both the phytotoxicity benchmark for soil and the background soil concentrations for the soil type are COPCs. If the chemical concentration or its detection limit falls below the proposed benchmark, the chemical may be eliminated from further study unless public concern or ancillary evidence suggests that it should be retained (Efroymson et al., 1997a,b). Three COPCs exceeded the screening-level phytotoxicity benchmarks used for the ERA. These include chromium, vanadium, and zinc. However, if a benchmark is exceeded by background soil concentrations, it is generally safe to assume that the benchmark is a poor measure of risk to the plant community (Efroymson et al., 1997a,b). None of the three COPCs with concentrations that exceeded the respective TRVs exceeded its background value. Additionally, chromium background exceeds its benchmark by 60 times, vanadium by 45 times, and zinc by 3 times. Thus, it is likely that potential risk to plants in OU-A is exaggerated.

Specific Uncertainties Associated with Avian and Mammalian Toxicity Reference Values

BTAG values were given priority in determining wildlife TRVs. BTAG TRVs tend to be conservative compared to TRVs from other sources. For example, the avian NOAEL for lead in the EcoSSL is 1.63 mg/kg-day, whereas the BTAG avian NOAEL (used in this risk assessment) is 0.014 mg/kg-day. The BTAG avian TRV is based on studies that employed lead acetate, a form of lead not commonly found in nature. Lead acetate is highly soluble and more bioavailable than inorganic lead or other lead salts, making it more toxic than other forms of lead that are commonly found in the environment. The EcoSSL TRVs were developed using only studies of the effects of inorganic lead compounds, which are more relevant at most sites, including OU-A.

Additionally, a BTAG TRV-low represents a lowest credible NOAEL. A TRV-low dose would not be expected to produce an adverse effect and is protective of an individual or population or organisms (DTSC, 2001). A BTAG TRV-high represents the mid-point of a variety of adverse effects and is not necessarily a LOAEL. A TRV-high dose would be expected to produce an adverse effect and is protective of an individual or population or organisms. A chemical with a TRV-low HQ greater than one and a high TRV HQ less than one (i.e., the "gray area") suggests further site-specific information should be collected to reduce uncertainty (DTSC, 2001). In the OU-A ERA all compounds that showed a low TRV HQ greater than one were still below background

(cadmium, lead, and nickel). For the reasons cited above, results based on the low BTAG values likely over estimate risk.

Constituents of Potential Concern not Quantitatively Assessed

Risk associated with a number of COPCs could not be quantitatively evaluated for one or more receptors because of a lack of exposure inputs and/or effects data. For most of these COPCs, little is known about environmental fate and transport and/or toxicity. Consequently, these compounds are rarely the focus of ecological risk assessments. The overall impact of not recommending these compounds as potential risk drivers is not considered to be significant, as this ERA addressed all compounds commonly evaluated in an ERA and commonly identified as risk management drivers on contaminated sites. However, the exclusion of COPCs that could not be quantitatively evaluated as potential risk drivers imparts uncertainty to the conclusions of this ERA, and may contribute to conclusions that, overall, provide an underestimation of risk to ecological receptors. To provide additional context, a more focused discussion on individual compounds and compound classes not quantitatively assessed follows.

- Antimony and thallium risk to birds: HQs could not be calculated for avian receptors because a BAF and/or avian TRV are not available. Antimony and thallium were quantitatively assessed for plants, invertebrates, and mammals. Although these AEs are not directly related to avian species, the quantitative assessment results from these AEs do provide context on overall ecological risk present from these metals.
- VOC exposure to ecological receptors: The availability of plant, invertebrate, avian, and mammal TRVs for VOCs is limited. Hence, several VOCs are not quantitatively assessed for one or more AE. However, VOC exposure is not believed to present significant ecological risk in OU-A for several reasons. First, most VOCs were infrequently detected, and therefore have limited exposure potential. Second, VOCs do not typically bioaccumulate, reducing the exposure potential for upper-trophic-level wildlife to VOCs. Lastly, of the VOCs quantitatively assessed none showed any potential risk. Although those VOCs quantitatively assessed are not necessarily direct surrogates for those VOCs not quantitatively assessed, as a class, VOCs do not appear to show significant potential ecological risk.
- Dioxins/furans exposure to plants and invertebrates: Dioxins/furans EPCs were calculated as TCDD TEQ values. These values are specific to avian and

mammalian receptors. Thus, benchmarks expressed as TCDD TEQ are not applicable in assessing invertebrate or plant exposure.

- Inclusion of dioxin-like PCBs in TEQ assessment: Dioxin-like PCBs were not included in TEQ calculations, which may result in an underestimate of total TEQ exposure. The toxicity of dioxin-like PCBs is, however, reflected in the TRVs for total PCBs as dioxin-like PCBs are part of a typical PCB mixture (as would have been used to conduct the toxicity studies the TRV was based on). Although there may be some uncertainty associated with total TEQ exposure, potential risk associated with PCB mixtures (including dioxin-like PCBs) is considered to be appropriately addressed by this assessment.

6.3.7 Results and Conclusions

The results of the ERA conducted for OU-A (see Table 6-34 for an overall summary of risk results) indicate that although risk calculations conducted for a number of receptors using low TRVs or conservative screening-level benchmarks resulted in HQs greater than one (indicating the potential for risk), high TRV HQs for these same COPC-receptor pairs were all equal to or less than one, and incremental exposure (as compared to ambient/background) is not indicated for any of the receptors with low TRV or screening-level benchmark HQs greater than one (based on comparisons of baseline soils EPCs [95% UCLs]).

Additional consideration was provided for the protection of special-status plants in OU-A, as they may be subject to a higher level of protection than non-special status plants (i.e., at the individual level) and isolated soil concentrations of a few metals exceed conservative phytotoxicity benchmarks and site-specific background thresholds for soil in OU-A. Two of the three special status plants known to occur in OU-A (Mendocino coast Indian paintbrush and short-leaved evax) are currently, and are expected to remain, distributed only along the bluff edge near the western boundary of OU-A where no risk is currently indicated for chromium, vanadium, and zinc (the only COPCs that exceeded screening-level phytotoxicity benchmarks in the BERA and have maximum concentrations that are slightly elevated compared to site background). If, because Blasdale's bent grass is shallow-rooting, only surface soils (0 to 0.5 foot bgs) are evaluated, chromium is only slightly above background at one location, vanadium is below background at all locations, and the maximum zinc concentration is less than twice background. Slightly higher concentrations were found in the 0- to 2-foot bgs interval, but as shown on Figures 6-5 and 6-6, present only in isolated areas. As discussed in the uncertainty discussion, phytotoxicity benchmarks that are

exceeded by background soil concentrations are considered as a poor measure of risk to the plant community (Efroymson et al., 1997a,b). Given that chromium background exceeds its benchmark by 60 times, vanadium by 45 times, and zinc by 3 times, risk conclusions based on these benchmarks should be viewed as highly uncertain.

Through the implementation of revegetation and restoration plans (which have not yet been developed for OU-A), the distribution of Blasdale's bent grass could be expanded into eastern portions of OU-A where they could be exposed to isolated elevated concentrations of chromium, vanadium, and zinc. Given the uncertainties associated with the phytotoxicity benchmarks, and the uncertainty about future revegetation and restoration plans, this ERA concludes that additional investigation is not required and risk management actions are not currently warranted.

7. Summary and Recommendations

The purpose of this RI Report was to provide a summary of the studies and data that characterize the nature and extent of contamination within OU-A and provide an evaluation of potential risks to human and ecological receptors under the anticipated future use scenario as a trail and park. Review of existing data identified some areas of OU-A where there were data gaps. In some areas there was a lack of sampling in a particular location or depth. Between April 16 and August 17, 2007, ARCADIS BBL collected the following samples in OU-A:

- 47 soil samples from 89 test pits
- 101 soil samples from 39 direct push (Geoprobe™) borings
- 175 soil samples from 80 hand auger borings
- 20 terrestrial invertebrate and 20 co-located plant samples.

Samples were analyzed for one or more of the following: Title 22 metals, TPH (TPHg, TPHd, and TPHmo), PAHs, VOCs, PCB congeners, and dioxins/furans.

7.1 Identification of Presumptive Remedy Areas

A preliminary evaluation of the data collected from OU-A determined that “presumptive remedies” are warranted in select areas of OU-A. A presumptive remedy area (PRA) is defined as an area that likely poses an unacceptable risk or exhibits other criteria that would require remedial action regardless of the results of any risk evaluations. Five PRAs were identified for OU-A through an initial data evaluation and any one of the following criteria:

- Presence of metals above the California Hazardous Waste threshold (California Code of Regulations Title 22 Social Security, Division Health Standards for the Management of Hazardous Waste, Chapter 11);
- Presence of PCBs above the action level for PCBs (under the performance-based approach) from the TSCA (40 Code of Federal Regulations 761.3);

- Presence of “significant” hot spots – areas where two or more adjacent sample locations had concentrations that were 10 times or more the residential CHHSL.

The establishment of PRAs for soils that meet the above criteria indicates that these areas will be addressed through remediation (both lateral and vertical extent).

7.2 OU-A North

In OU-A North, the Glass Beaches (Glass Beach 1, Between Glass Beach 1 and 2, Glass Beach 2, Between Glass Beaches 2 and 3, Glass Beach 3, East of Glass Beach 3) in Parcel 1 and the Parcel 3 Geophysical Anomaly/Former Scrap Yard Area were investigated.

In general, the Glass Beach Areas soil showed the following COIs above their respective screening levels: arsenic and cadmium (both just slightly above background), lead, B(a)P TEQs, and TCDD TEQs. However, sampling results have typically defined the horizontal and vertical extent of the impacts and were determined to be sufficient for risk assessment purposes. Exceedances were typically minor (less than 10 times background or screening levels) or limited in spatial extent, with the exception of Glass Beach 2 where a small portion had elevated concentrations of lead (meeting California Hazardous Waste criteria) Therefore, a portion of this AOI has been identified as a PRA. Soil in this area will be remediated to a depth of approximately 2 feet. Soil outside the PRA did not contain lead above screening levels.

In Parcel 3, the soil showed the following COIs above their respective screening levels: arsenic, cadmium, and vanadium (all just slightly above background); PAHs; TPH; and PCBs. However, PCBs were the only analyte that exceeded their screening levels by 10 times, and total PCBs also exceeded the TSCA performance-based criterion of 1 mg/kg. The elevated PAHs and TPH are also within this same area. Therefore, this area has been identified as a PRA. Soil in this area will be remediated to a depth of approximately 6 to 12 inches bgs. PCB soil concentrations below 0.5 to 1 foot bgs and outside the PRA did not exceed screening levels.

7.3 OU-A South

In OU-A South, the Parcels 6 and 8 Coastline, North of the Parcel 8 Clinker Area, Parcel 8 Clinker/Fill Area, Parcel 10 Geophysical Anomaly/Clinker Area, Parcel 10 Fill Area, the Former Railroad Tracks, Blowhole, Parcel 8 Fill Area, and North of Native American Homes were investigated. The results from soil samples collected at AOIs

Parcel 6 and 8 Coastline, North of the Parcel 8 Clinker Area, Parcel 8 Clinker/Fill Area, Blowhole, Parcel 8 Fill Area, and North of Native American Homes showed that the chemicals investigated did not exceed background and/or screening levels. The AOIs that had concentrations of COIs above background and/or screening levels were the Parcel 10 Geophysical Anomaly/Clinker Area, Parcel 10 Fill Area, and Former Railroad Tracks. The following is a summary of the findings in these AOIs:

- Parcel 10 Geophysical Anomaly/Clinker Area. The analytical results for soils showed the following COIs above their respective screening levels: arsenic, lead, and vanadium (just above background levels in most locations); and B(a)P and TCDD TEQs. Other chemicals were either not detected or detected below background and/or screening levels. Although arsenic, lead, vanadium, B(a)P, and dioxins/furans were detected above screening levels, the exceedances were relatively minor (less than 10 times background or screening levels) or limited in spatial extent, and the extent is characterized and defined sufficiently for risk assessment purposes.
- Parcel 10 Fill Area. The analytical results for soils showed the following COIs above their respective screening levels: arsenic (just above background levels), B(a)P TEQs, and TCDD TEQs over their respective background and/or screening levels. Other chemicals were either not detected or detected below background and/or screening levels. Although arsenic and B(a)P were detected above screening levels, the exceedances are minor, and extent is defined sufficiently for risk assessment purposes. The elevated TCDD TEQ concentrations were found mainly within three areas in the Parcel 10 fill area. Concentrations at nine locations were more than 10 times the screening level (CHHSL: 4.6 pg/g). Three small areas were identified as PRAs based on the criteria described above: one in the northern portion of the AOI and two in the southern portion of the AOI. Soils in these areas are presumed to be addressed by excavation to a depth ranging from 2 to 5 feet bgs. TCDD TEQ soil concentrations outside the PRAs either did not exceed or only slightly exceeded the screening level and are further assessed in the risk assessment.
- Former Railroad Tracks. The analytical results from Former Railroad Tracks showed exceedances of B(a)P TEQs over the screening level. Other chemicals were either not detected or detected below background and/or screening levels. Although B(a)P TEQ concentrations were detected above screening levels, the exceedance is low in magnitude and appears to be very limited in extent.

7.4 Groundwater and Surface Water

Based on the limited historical activities and limited detections of COIs in soil samples from OU-A, monitoring wells present in OU-A are located in Parcel 10 in OU-A South. These include monitoring wells MW-10.1 through MW-10.4. Historically, dissolved arsenic, dissolved beryllium, benzene, and BEHP have been the only four COIs detected in Parcel 10 groundwater at concentrations in excess of their respective applicable screening levels. Other chemicals were either not detected or detected below background and/or screening levels. The exceedances of screening levels discussed above are minor, are not considered to be of significant concern, and unlikely to result in unacceptable risks.

There are six groundwater seep locations in OU-A. Four (Springs SP-1.1 through SP-1.4) are located in Parcel 1, one (Spring SP-10.1) is located in Parcel 10, and one (Spring SP-8.1) is located in Parcel 8. These seeps were sampled in 2006 and 2007. The samples from the seeps showed exceedances of dissolved beryllium, naphthalene, and TPHmo above their respective screening levels. Other chemicals were either not detected or detected below background and/or screening levels. Exceedances of screening levels for these springs are minor and considered insignificant given the high level of dilution (for example, wastewater discharges are given a 50-fold dilution factor in this area).

7.5 Summary and Key Nature and Extent Findings

As discussed previously, the shallow soil in OU-A is primarily impacted with select metals, B(a)P, TPHd and TPHmo, PCBs, and dioxins/furans above screening levels. Two areas in OU-A North (Glass Beach 2 and the Parcel 3 Former Scrap Yard) and three areas within OU-A South (all within the Parcel 10 Fill Area) have been targeted as requiring presumptive remedies because of elevated concentrations of lead, PCBs, or dioxin/furans. The soil from these areas can be presumed to be remediated and will be addressed in forthcoming remedial planning.

7.6 Risk Assessment

The following summarizes the results of the risk evaluations, which were conducted based on the assumption of future recreational site use and the implementation of remediation in five PRAs.

7.6.1 Human Health Results

All noncancer estimates for OU-A were below the agency threshold of one for noncancer (HI) effects and below the 10 µg/dl blood-lead level for each of the receptors under all scenarios.

Arsenic accounts for over 90% of the total cancer risk estimates at OU-A; however, the arsenic EPCs are well within ambient/background conditions. With the exception of the recreator receptors, the CTE cancer risk estimates in both EUs were below CalEPA's threshold of 1×10^{-6} for carcinogenic effects, even with arsenic included. All risks for all receptors were below 1×10^{-6} once arsenic was excluded. The threshold of 1×10^{-6} was exceeded in both EUs for both the RME and CTE scenarios for the recreator and the RME scenario for the construction and maintenance/utility workers only when background levels of arsenic are included.

Based on this assessment, site-related chemicals do not pose an unacceptable risk to future receptors in OU-A. As discussed previously, risk estimates are based on the assumption that five PRAs are addressed through remediation.

7.6.2 Ecological Results

The results of the ERA indicate that risk calculations conducted for a number of receptors using maximum concentrations (screening level assessment), toxicity values, or conservative screening-level benchmarks resulted in HQs > 1 (indicating the potential for risk).

However, when more reasonable assumptions and high toxicity values were used, HQs were all equal to or less than one. Additionally, incremental exposure (as compared to ambient/background) is not indicated for any of the receptors with low TRV or screening-level benchmark HQs greater than one (based on comparisons of EPCs to upper bound background levels).

Evaluation of special-status plants showed that isolated soil concentrations of a few metals (chromium, vanadium, and zinc) exceed conservative phytotoxicity benchmarks for soil and site-specific soil background levels. However, the phytotoxicity benchmarks are also exceeded by background soil concentrations by as much as 60 times. If only surface soils (0 to 0.5 foot bgs; the typical root depth of the relevant special-status species) are evaluated, chromium is only slightly above background at one location, vanadium is below background at all locations, and the maximum zinc concentration is

less than twice background. Slightly higher concentrations were found in the 0- to 2-foot bgs interval, but in isolated areas.

Given the results of the ERA and uncertainties associated with the phytotoxicity benchmarks used to assess special-status plant species, the results of the ERA indicate that additional management actions beyond the planned PRAs are not warranted.

7.7 Overall Summary

This RI Report provides sufficient characterization of the nature and extent of COIs within OU-A. Five PRAs were identified as appropriate for remedial action based on factors that included the presence of hazardous waste (lead), PCBs above the TSCA threshold, or areas considered “hot spots” with concentrations of chemicals over 10 times screening levels. Based on the assessment of risks following assumed remediation of the PRAs, risks are predicted to be within the acceptable range. The five PRA areas will be carried forward into the remedial planning process. No other areas warrant further evaluation.

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