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Final
Feasibility Study
Operable Unit E
Former Georgia-Pacific
Wood Products Facility
Fort Bragg, California

12 September 2019

Prepared for

Georgia-Pacific LLC
133 Peachtree Street NE
Atlanta, Georgia 30303

KJ Project No. 1665018*19

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List of Acronyms & Abbreviations

%	percent
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
AOC	Area of Concern
AOI	Area of Interest
AME	Acton•Mickelson•Environmental, Inc.
ARARs	applicable or relevant and appropriate requirements
Arcadis	Arcadis U.S., Inc.
AS	Air Sparge
AST	aboveground storage tank
B(a)P	benzo(a)pyrene
BBL	Blasland, Bouck & Lee, Inc.
BERA	baseline ecological risk assessment
BHHERA	Baseline Human Health and Ecological Risk Assessment
bgs	below ground surface
bss	below sediment surface
btoc	below top of casing
CalEPA	California Environmental Protection Agency
CCC	California Coastal Commission
CDP	Coastal Development Permit
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
City	City of Fort Bragg, Mendocino County, California
CMP	Comprehensive Monitoring Program
CMP Update No. 6	Comprehensive Monitoring Program Update Number 6 (Arcadis, 2013c)
COC	chemical of concern
COI	chemical of interest
Construction Completion Report	Construction Completion Report for Foundation and Ash Pile Removal Projects (Arcadis BBL, 2007a)
COPC	chemical of potential concern
CRAM	California Rapid Assessment Method
CSM	conceptual site model
cy	cubic yards
dioxin	polychlorinated dibenzo-*p*-dioxin

DP	direct push (sample ID moniker)
DSOD	California Department of Water Resources, Division of Safety of Dams
DTSC	California Environmental Protection Agency, Department of Toxic Substances Control
ELCRs	excess lifetime cancer risk
EPC	exposure point concentration
ERA	ecological risk assessment
EqP	equilibrium partitioning
ESA	environmental site assessment
ESHA	environmentally sensitive habitat areas
EU	Exposure Unit
°F	degrees Fahrenheit
FS	Feasibility Study
ft/ft	foot per foot or feet per foot
furan	polychlorinated dibenzofuran
GAC	granular activated carbon
Georgia-Pacific	Georgia-Pacific LLC
GRA	general response action
HA	hand auger (sample ID moniker)
HDPE	high-density polyethylene
HERO	DTSC Human and Ecological Risk Office
HI	hazard index
HQ	Hazard Quotient
Hygienetics	Hygienetics Environmental Services, Inc.
IARAP	Interim Action Remedial Action Plan (Arcadis, 2008b)
IC	Institutional controls
IRM	interim remedial measure
ISB	in-situ biological oxidation
ISCO	in-situ chemical oxidation
Kennedy/Jenks	Kennedy/Jenks Consultants
LBP	lead-based paint
LUC	Land Use Controls
MCL	Maximum Contaminant Level
MES	Mobile Equipment Shop
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter

MNA	monitored natural attenuation
MPE	multi-phase extraction
MW	monitoring wells
NAVD88	North American Vertical Datum of 1988
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	No further action
NTE	Not to exceed
O&M	operation and maintenance
Order	Site Investigation and Remediation Order (Docket No. HAS-RAO 06-07-150)
ORM	oxygen-releasing material
OU	Operable Unit
OU-C and D RI Report	Remedial Investigation, Operable Units C and D (Arcadis, 2011a)
OU-E RI Report	Final Remedial Investigation Report Operable Unit E (Arcadis, 2013a)
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pg/g	picogram(s) per gram
pg/kg	picogram(s) per kilogram
ppm	parts per million
ppt	parts per trillion
PRA	presumptive remedy area
PRB	permeable reactive barrier
PSL	primary screening level
RAA	removal action area
RACR	Remedial Action Completion Report
RAO	remedial action objective
RAP	remedial action plan
RAW	Remedial Action Work Plan
RBTL	risk-based target levels
RI	remedial investigation
RWQCB	Regional Water Quality Control Board
SED	sediment (sample ID moniker)
sf	square foot or square feet
site	Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

SMP	soil management plan
Stormwater Construction General Permit	General Permit for Discharges of Storm Water Associated with Construction Activity
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
TBC	to-be-considered
TCDD	tetrachlorodibenzo-p-dioxin
TEQ	toxic equivalent
TOC	total organic carbon
TPH	total petroleum hydrocarbon
TPHd	total petroleum hydrocarbons in the diesel range
TPHg	total petroleum hydrocarbons in the gasoline range
TPHmo	total petroleum hydrocarbons in the motor oil range
TRC	TRC Companies, Inc.
µg/L	microgram per liter
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
WRA	WRA Environmental Consultants
WQO	Water Quality Objective

Executive Summary

This Feasibility Study (FS) was prepared by Kennedy/Jenks Consultants (Kennedy/Jenks) on behalf of Georgia-Pacific LLC (Georgia-Pacific) for Operable Unit E (OU-E) at the former Georgia-Pacific Wood Products Facility located at 90 West Redwood Avenue in Fort Bragg, Mendocino County, California (site), as shown on Figure 1-1. The purpose of this FS is to identify cost effective remedial methods for OU-E that will meet cleanup objectives and comply with applicable laws and requirements.

This FS includes an updated conceptual site model (CSM) that summarizes the site setting, investigations and interim remedial actions, and the nature and extent of chemicals of concern. This FS describes the remedial action objectives (RAOs) and applicable or relevant and appropriate requirements (ARARs) for the site, as well as an evaluation of general response actions (GRAs) and a preliminary screening of potentially feasible process options. The process options that were carried through the preliminary screening are then further developed into remedial alternatives and evaluated against comprehensive screening criteria. The preferred alternatives were selected on a comparative basis, as summarized in Section 8 and presented on Table 8-1.

Background

OU-E is one of five operable units on the site (Figure 1-2) and consists of approximately 12 acres of man-made ponds and seasonal wetland areas and 45 terrestrial acres divided into eight areas of interest (AOIs). Aquatic areas include Ponds 1 through 9 and the North Pond. Terrestrial areas include the Water Treatment and Truck Dump AOI, Sawmill #1 AOI, Compressor House and Lath Building AOI, Powerhouse and Fuel Barn AOI, and Pond 8 Fill Area AOI as well as the Riparian AOI, Interim Remedial Measure (IRM) AOI and West of IRM AOI (Figure 1-3), which were transferred from operable units C and D. This FS addresses soil and groundwater in the terrestrial AOIs and aquatic sediment in the aquatic AOIs. Industrial features in OU-E were related to power production, milling of timber, water treatment, management of fly ash, and fuel storage. The ponds were constructed for operational purposes, including management of wastewater from site operations, providing a source of water for firefighting, and use as a log pond. Pond 8 was constructed during the initial development of the Mill Site around 1885 as the log pond. Based on aerial photos, the earliest documented size of Pond 8 was approximately 13.23 acres, and minimal changes in pond size occurred until after 1966 when several fill operations occurred. Pond 8 is currently approximately 7.24 acres (see Figure 1-7). Additional details about these modifications or historical Pond 8 maintenance dredging or fill are not documented in available site historical information. Ponds 1 – 4, 6, 7, and the North Pond were constructed during operation of the Mill between 1957 and 1996 (see Figure 1-6). Pond 2 is present on the earliest available aerial photo, but appears to be smaller than later configurations and may have been a site feature prior to development of the surrounding area. Pond 8 also receives stormwater runoff from portions of the Mill Site via surface sheet flow and the City of Fort Bragg, California (City) via the City's stormwater collection system. The majority of industrial features within OU-E have been removed. Soil was placed in portions of the terrestrial area to cover foundations in the lowland following building demolition and interim cleanup activities in those areas. Currently, OU-E is vacant, there are no active structures or uses in the terrestrial area and the primary use of the aquatic areas, specifically Pond 8, is to provide stormwater management for the City prior to discharge to the ocean. The foreseeable future use of OU-E is as continued stormwater management facilities, parkland, and recreational trail development.

For development of remedial alternatives, AOIs were grouped into areas of concern (AOCs) due to similarities in nature and extent of chemicals of interest (COIs) and affected media. In 2016, GP submitted a Remedial Action Work Plan (RAW) for OU-E that describes soil and sediment removal activities to be completed prior to the construction of the next phase of the City of Fort Bragg Coastal Trail project. The RAW was approved on 13 October 2016. AOIs that were included in the RAW are separated from other AOIs to simplify this OU-E FS. Chemicals that were identified as potential risk drivers in the BHHERA are termed chemicals of concern (COC) herein. The RAW removal activities were complete in 2017, as summarized in the Final Remedial Action Completion Report (RACR; Kennedy/Jenks 2018). The four lowland terrestrial soil AOIs that are to be further evaluated in this FS (Water Treatment and Truck Dump AOI, Sawmill #1 AOI, Compressor House and Lath Building AOI, and the Powerhouse and Fuel Barn AOI) were grouped into the ‘Lowland Terrestrial Soil AOI’ and approved for no further action (NFA; DTSC 2018a). The Pond 8 Fill Area AOI is not being considered due to the absence of chemicals of potential concern (COPCs) above relevant screening levels. Additionally, the IRM and West of IRM groundwater AOIs were combined into the ‘IRM and West of IRM AOC’. Aquatic sediment AOIs (i.e., pond and riparian AOIs) will be evaluated individually. The Pond 5 and 9 AOIs are not considered in this FS as no further action is necessary per the approved *Baseline Human Health and Ecological Risk Assessment (BHHERA) – Operable Unit E* (Arcadis, 2015b).

Polychlorinated dibenzo-p-dioxin (dioxin) was evaluated by estimating the 2,3,7,8-tetrachlorodibenzo-p-dioxin [2,3,7,8-TCDD] toxic equivalent (TEQ). The detected dioxin/furan congener concentrations were multiplied by their corresponding toxic equivalency factor (TEF) (Van den Berg et al. 2006), and the results were summed to develop a 2,3,7,8-TCDD TEQ concentration per analyzed sample. A similar approach is used to summarize polycyclic aromatic hydrocarbon (PAH) congener concentrations to a TEQ by multiplying each congener by a TEF and summing the results to a single value.

The AOCs evaluated and COCs relevant in each include:

AOIs/AOCs included in the RAW:

- Lowland Terrestrial Soil – petroleum constituents (TPHd), B(a)PTEQ, dioxin TEQ (2,3,7,8-tetrachlorodibenzo-p-dioxin [2,3,7,8-TCDD]), and lead
- Ponds 1 through 4 (Southern Ponds) Aquatic Sediment – arsenic and dioxin TEQ
- Pond 7 Aquatic Sediment – arsenic and dioxin TEQ
- Riparian Aquatic Sediment – dioxin TEQ

AOCs not included in the RAW:

- North Pond and Pond 6 Aquatic Sediment – arsenic and dioxin TEQ

- Pond 8 Aquatic Sediment – arsenic and dioxin TEQ
- OU-E Groundwater.

Remedial Action Objectives and Preliminary Evaluation

The RAOs presented below have been developed based on the current environmental conditions and anticipated future use of the site.

1. Protect human health and the environment through mitigation of exposure pathways of groundwater, surface water, soil, and/or sediment that contain COCs at concentrations greater than the proposed site cleanup goals under the reasonably foreseeable future land use scenarios.
2. For the AOC(s) with COC-impacted groundwater, provide a remediation alternative that will promote mitigation of COC-impacted groundwater to ultimately achieve North Coast Regional Water Quality Control Board (RWQCB) water quality objectives (WQOs).
3. Provide an economically reasonable and technically feasible remedy.
4. Achieve the remedy in a reasonable time-frame.

In conjunction with the RAOs, ARARs were established to ensure that the initial development of remedial alternatives consider compliance requirements. GRAs were developed for initial comparison of categories of process options against RAOs and ARARs. GRAs evaluated include no action, institutional controls, containment, in-situ treatment, and ex-situ treatment. All categories were carried on for further development and evaluation as process options.

Specific process options that fit into each of the GRA categories listed above have been preliminarily screened for effectiveness, implementability, and overall cost. Process options that were carried through this preliminary screening process were either evaluated as a stand-alone alternative or combined with other process options into a remedial alternative.

Evaluation of Soil, Sediment, and Groundwater Remediation Alternatives

Remedial alternatives developed from the feasible process options have been screened according to U.S. Environmental Protection Agency (USEPA)-specified evaluation criteria and compared to identify a recommended alternative per AOC. The criteria used to screen the remedial alternatives are summarized below, followed by the recommended alternatives for each AOI.

Approved OU-E Removal Action Work Plan

The OU-E RAW was prepared to expedite remediation in select AOCs to facilitate construction of the City of Fort Bragg's coastal trail (Arcadis, 2016a). Excavation and disposal was approved as the remedial action for the Lowland Terrestrial Soil AOC, the Pond 7 Aquatic Sediment AOC, the Ponds 1 through 4 (Southern Ponds) Aquatic Sediment AOC, and the Riparian Aquatic Sediment AOCs. Hot spots were removed in multiple areas throughout the Lowland Terrestrial AOC, in one location in Pond 2, in one location in Pond 3, and in four locations in the Riparian AOC, and all sediment was removed from Pond 7. Implementation was completed in 2017. Clean imported soil was utilized for backfill in each of the AOCs. Implementation of the OU-E RAW and confirmation sampling results are described in the Remedial Action Completion Report for Operable Units OU-C, OU-D, and OU-E (RACR; Kennedy/Jenks 2018).

Results of Remedial Alternatives Evaluation and Comparison

Pond 8, Pond 7, North Pond and Pond 6 Aquatic Sediment AOCs – institutional controls: containment, land use controls, sediment management, and long-term operations and maintenance. Due to the nature and extent of constituents and evaluation of the nine criteria, institutional controls are the recommended alternative for the Pond 8, Pond 7, North Pond and Pond 6 Aquatic Sediment AOCs. Institutional controls would include land use controls (LUCs) and a comprehensive soil management plan (SMP) to further reduce the potential pathways for future site receptors. Site use and sediment disturbing activities would be controlled by the LUCs and SMP until agency approval for unrestricted use is received based on COC degradation or future remediation.

OU-E Groundwater AOC – monitored natural attenuation (MNA). Based on historical groundwater monitoring data and the nine evaluation criteria, MNA with use restrictions is the recommended alternative. MNA uses long-term monitoring and analysis to demonstrate established stable or decreasing COC trends and a low risk to human health and the environment. LUCs would prohibit the use of groundwater to eliminate exposure to COCs. Groundwater use would be restricted until Water Quality Objectives are achieved or agency approval for unrestricted use is received.

Table 7-1 presents a comparison of the retained alternatives for each AOC and Table 8-1 presents a summary of the recommended alternatives for each AOC. Cost estimates associated with these remedies are included in Appendix A.

Section 1: Introduction

This Feasibility Study (FS) was prepared by Kennedy/Jenks Consultants Inc. (Kennedy/Jenks) on behalf of Georgia-Pacific LLC (Georgia-Pacific) for Operable Unit E (OU-E) at the former Georgia-Pacific Wood Products Facility (site) located at 90 West Redwood Avenue in Fort Bragg, Mendocino County, California, as shown on Figure 1-1.

This FS was prepared as required by the California Department of Toxic Substances Control (DTSC) under Site Investigation and Remediation Order Docket No. HAS-RAO 06-07-150 (Order) in accordance with the federal National Oil and Hazardous Substances Pollution Contingency Plan (NCP; U.S. Environmental Protection Agency [USEPA], 1990) and the Guidance for Conducting Remedial Investigations and Feasibility Studies (RI/FS) Under the Federal Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA; USEPA, 1988).

The 415-acre site is located west of Highway 1 along the Pacific Ocean coastline and is bounded by Noyo Bay to the south, the City of Fort Bragg (City) to the east and north, and the Pacific Ocean to the west. Union Lumber Company began sawmill operations at the site in 1885. Georgia-Pacific acquired the site in 1973. Sawmill operations at the site included lumber production and power generation by burning residual bark and wood. Georgia-Pacific ceased operations on 8 August 2002. Much of the equipment and structures associated with the sawmill operations have been removed. The City acquired and improved 82 acres of land known as Noyo Headlands Park, which extends over the northern and southern coastal bluff at the former Mill Site. Noyo Headlands Park includes 5.4 miles of trails and various improvements. An additional public coastal trail extending from the southern end of the property 0.8 miles to the north side of the City of Fort Bragg Waste Water Treatment Plant on five acres was opened in 2016 (called the “Coastal Trail”). With the exception of the public coastal trails, the site is fenced, security patrolled and locked to restrict trespassers.

OU-E is one of five operable units on the site (Figure 1-2) and consists of approximately 12 acres of man-made ponds and seasonal wetland areas and 45 terrestrial acres divided into eight areas of interest (AOIs). Aquatic areas include Ponds 1 through 9 and the North Pond. Terrestrial areas include the Water Treatment and Truck Dump AOI, Sawmill #1 AOI, Compressor House and Lath Building AOI, Powerhouse and Fuel Barn AOI, and Pond 8 Fill Area AOI as well as the Riparian AOI, Interim Remedial Measure (IRM) AOI and West of IRM AOI (Figure 1-3), which were transferred from operable units C and D. Predominant industrial features in OU-E were related to power production, milling of timber, water treatment, management of fly ash, and fuel storage. The ponds were constructed for operational purposes, including management of wastewater from site operations, providing a source of water for firefighting, and use as a log pond (see Section 1.2.2). Pond 8 was constructed during the initial development of the Mill Site around 1885 as the log pond. Based on aerial photos, the earliest documented size of Pond 8 was approximately 13.23 acres, and minimal changes in pond size occurred until after 1966 when several fill operations occurred. Pond 8 is currently approximately 7.24 acres (see Figure 1-7). Additional details about these modifications or historical Pond 8 maintenance dredging or fill are not documented in available site historical information. Ponds 1 – 4, 6, 7, and the North Pond were constructed during operation of the Mill between 1952 and 1996 (see Figure 1-6). Pond 2 is present on the earliest available aerial photo but appears to be smaller than later configurations and may have been a site feature prior to development of the surrounding area. Pond 8 also receives stormwater runoff from portions of the Mill Site via surface sheet flow and the City via the City's stormwater collection system. The majority of industrial features within OU-E have been removed. In locations shown on Figure 1-4, soil was placed in portions of the terrestrial area to cover foundations in the lowland following building demolition and interim cleanup activities in those areas. Currently, OU-E is vacant, there are no structures or uses in the terrestrial area and the primary use of the aquatic areas, specifically Pond 8, is to provide stormwater management for the City prior to discharge to the ocean. However, the Coastal Trail will soon be installed through a portion of OU-E. The trail alignment will be separated from the Mill Site with property line fencing that will be appropriately marked with warning signs. The foreseeable future use of OU-E is as continued stormwater management facilities, parkland, and recreational trail development. Some commercial land use may occur in Parcel 5, depending on the outcome of the City of Fort Bragg planning process.

1.1 Objectives

The purpose of this FS is to develop and evaluate appropriate remedial alternatives such that relevant information concerning the remedial action options can be presented and an appropriate remedy selected. Alternatives shall be developed that protect human health and the environment by recycling waste or by eliminating, reducing, and/or controlling risks posed through each pathway by the site. The FS is based on data presented in the *Final Remedial Investigation Report Operable Unit E* (OU-E RI Report; Arcadis, 2013a) and the *Baseline Human Health and Ecological Risk Assessment (BHHERA) – Operable Unit E* (Arcadis, 2015b) and data collected from subsequent investigations (see Section 2.2). The FS also includes summaries of remedial actions approved and completed for the OU-E Lowlands AOI, Ponds 1, 2, 3, and 4 (the Southern Ponds) AOC, Pond 7 AOC, and Riparian AOI, which are presented in the OU-E Removal Action Work Plan (OU-E RAW; Arcadis, 2016a).

The scope of this FS includes all OU-E areas recommended for inclusion based on the OU-E RI Report and BHHERA (Arcadis, 2013a and 2015b), with addition of the following areas:

- IRM AOI
- West of IRM AOI
- Riparian AOI

These areas are located within and adjacent to the Mill Pond, originally within OU-C and OU-D; however, they were moved to be included in this FS as these AOIs are closely associated with the AOIs from OU-E (Arcadis, 2012a).

1.2 Operational History

The following documents provide information about the operational history at the site, OU-E, and AOIs formerly associated with OU-C and OU-D:

- Phase I Environmental Site Assessment (ESA; TRC Companies, Inc. [TRC], 2004a)

- Phase II ESA (TRC, 2004b)
- Additional Site Assessment Report (TRC, 2004c)
- Work Plan for Additional Site Assessment (Acton•Mickelson•Environmental, Inc. [AME], 2005a)
- Current Conditions Report (Blasland, Bouck & Lee, Inc. [BBL], 2006)
- Dioxin Sampling and Analysis Report (AME, 2006a)
- Construction Completion Report for Foundation and Ash Pile Removal Projects (Construction Completion Report; (Arcadis BBL, 2007a)
- Fuel Oil Line Removal Report (Arcadis, 2008a)
- Final Interim Action Remedial Action Plan and Feasibility Study (Arcadis, 2008b)
- Remedial Investigation, Operable Units C and D (Arcadis, 2011a) [OU-C and D RI Report]
- Feasibility Study, Operable Units C and D (Arcadis, 2012a)
- Final Remedial Investigation Report Operable Unit E (Arcadis, 2013a)
- Baseline Human Health and Ecological Risk Assessment - Operable Unit E (Arcadis, 2015)
- Removal Action Work Plan Operable Unit E (Arcadis, 2016a).

A general summary of the operational history of the terrestrial area and ponds associated with OU-E is provided below, followed by a description of the historical use of each AOI, focusing on those areas where activities could have resulted in a release of hazardous substances. The AOIs have been grouped into three Areas of Concern (AOCs); lowland terrestrial, aquatic, and groundwater) depending on nature and extent of constituents. The AOI locations and site features are shown on Figure 1-3.

1.2.1 Lowland Terrestrial Areas of Interest

1.2.1.1 Water Treatment and Truck Dump AOI

The Water Treatment and Truck Dump AOI is located in the northwest section of OU-E (Figure 1-4). Former features in the area include the Alum Tank, Water Treatment Plant, Sewage Pump Station, Water Supply Switch Building, Water Valve Shed, Water Tower, Powerhouse Fuel Storage Shed, Chipper Building, Truck Dump, Truck Dump Hydraulic Unit Building, and the Bunker Fuel Aboveground Storage Tank (AST) Area.

Built in the 1970s, the Alum Tank, Water Treatment Plant, Sewage Pump Station, Water Supply Switch Building, and Water Valve Shed supported water treatment processes. The Water Treatment Plant treated water to prevent corrosion and scaling of the cooling towers. Inside the plant were two treatment tanks and two air compressors. Each treatment tank had a mixing tank, clarifier, and additional settling tank. The following chemicals were identified inside the plant during the Phase I ESA (TRC, 2004a): liquid chlorine (mostly empty 350-gallon tank), alum (250-gallon tank in secondary containment), caustic soda (350-gallon tank in secondary containment and two 55-gallon drums), and ammonium chloride. Site documents also suggested that sodium hypochlorite (approximately 500 gallons) and sodium hydroxide (350 gallons) were present.

Outside the plant, a concrete AST may have held a treated water supply for the Powerhouse. About 300 feet northwest of the plant was a 4,000-gallon AST containing alum[1]. The Alum Tank foundation and the Water Treatment Plant foundation were broken up, and the concrete was moved to the concrete storage area in August 2006. After demolition of the foundations, a dry cap[2] was placed in the removal area.

The Chipper Building consisted of a wood structure with a concrete floor. The Truck Dump was located next to the Chipper Building. The Truck Dump included a hydraulic system formerly used to empty trucks of their wood fuel loads (it was assumed to have been built in the mid-1970s); inside the building was a transformer. A concrete slab was used for structural support at this location. The walls of the Chipper Building were left in place, as they support a slope north of the building. After the demolition of the foundations in June and July 2006, a dry cap was placed in the area. The majority of the dry cap was later excavated with the removal of the Fuel Oil Line in 2007 (Arcadis, 2008a), which is further discussed in Section 2.2.3.2.

The Sewage Pumping Station consists of a concrete slab and an underground concrete tank.

The Water Supply Switch Building was constructed of corrugated metal with a concrete foundation. The foundation was removed and a dry cap installed in July 2006.

The Powerhouse Fuel Storage Shed was built in 1995 with corrugated metal, had a concrete floor and berm (secondary containment), and was open to the north and east. The shed contained three horizontal ASTs, each with a capacity of 10,000 gallons. In May 1999, 4,000 gallons of fuel spilled within secondary containment and was cleaned up. Soil and groundwater sampling conducted as part of the Phase II ESA (TRC, 2004b) showed concentrations of total petroleum hydrocarbons (TPH) below screening levels. To the west of the building, there was a 30,000-gallon Water Tower, built from wood with a concrete base. The Water Tower pad and the Fuel Storage Area were removed and a dry cap installed in July 2006.

Backup fuel was stored in two ASTs in the Former Bunker Fuel AST area north of the Powerhouse. Both ASTs had concrete secondary containment and were removed in 1996. Underground piping associated with the ASTs was excavated in 2007 (see Section 2.2.3.2 and the *Fuel Oil Line Removal Report* [Arcadis, 2008a]).

1.2.1.2 Sawmill #1 AOI

The Sawmill #1 AOI is an "L" shaped area located north of the eastern half of Pond 8. Former features in the area include the Sawmill #1 Building, Press Building, Green Chain (and Elevated Roadway), Lath and Shake Mill, Refuse Wood for Fuel Area, Engine House Area, Number 5 Shingle Mill Area, and AST (Figure 1-4).

Historical photos, Sanborn maps, and interviews with site personnel suggest that the former Sawmill #1 Building was constructed in the late 1880s. It was equipped with saws, edgers,

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[1] Alum is a combination of an alkali metal (such as sodium, potassium, or ammonium) and a trivalent metal (such as aluminum, iron, or chromium). In water treatment, alum is used as a coagulant, which binds together very fine suspended particles into larger particles that can be removed by settling and filtration.

[2] Dry caps were placed where groundwater was not considered likely to extend to the bottom of excavations. They consisted of a geosynthetic clay liner covered with clean fill material.

trimmers, wood chippers, cyclones, and target boxes. It generally handled larger diameter logs, which were first debarked by either hydraulic or mechanical means, cut to remove tattered edges, and trimmed. Finished logs were sent to re-saw areas for size reduction or to the Green Chain for manual sorting and stacking in preparation for transfer to storage areas, planer mill, shipping areas, or drying areas. The Sawmill #1 ceased operations in 1998; later that year, some of the aboveground structures of the Sawmill #1 Building and the Green Chain were demolished. The remainder of the Sawmill #1 Building was demolished in 1999 and 2000. The concrete foundations of the Sawmill #1 Building, as well as the concrete structural supports for the Green Chain, were demolished in June and July of 2006. After the demolition, a wet cap[3] was placed over the area, which was completed in September 2006.

The Press Building was constructed of wood with a concrete floor and was located south of the former Sawmill #1 Building. The building contained a sugar cane press until the early 1990s when it was removed. Press Building pad and footings removal occurred in July 2006, followed by placement of a dry cap in the removal area.

The former Lath and Shake Mill, Refuse Wood for Fuel Area, Engine House Area, AST, and Number 5 Shingle Mill Area were also present in the Sawmill #1 AOI. These areas are illustrated on Figure 1-4.

1.2.1.3 Compressor House and Lath Building AOI

The Compressor House and Lath Building AOI included two small buildings (Compressor House 1 and Compressor House 2), Electrical Shop, Compressor House Shed, Lath Building, and a secondary containment structure (Figure 1-4).

Compressor House 1, an enclosed structure composed of corrugated metal with concrete floors, housed two compressors and related maintenance equipment and materials (e.g., 55-gallon oil drums, used oil filter drums). A compressed air AST and backup air compressor were located outside the building.

Compressor House 2, a smaller corrugated metal structure with concrete floors, stored 55-gallon oil drums and various other materials. Three overhead transformers were observed south of Compressor House 2 during the Phase I ESA (TRC, 2004a).

The Compressor House Shed, constructed of corrugated metal without a concrete foundation/floor, housed a large metal tank with an air pressure gauge.

Compressor Houses 1 and 2 were removed in July 2006 (Arcadis BBL, 2007a) and covered with a dry cap, the majority of which was later excavated as part of the interim action to remove TPH and metal-impacted soil from under the former Electrical Shop, Compressor House 1, and Compressor House 2 buildings (Arcadis, 2010a).

The Lath Building was located northwest of the former Compressor House buildings, near the former Sawmill #1 Building. It housed a small process area that made products from

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[3] Wet caps were placed where groundwater was considered likely to extend to the bottom of excavations. They consisted of a geosynthetic clay liner covered with one to four inches of crushed concrete, covered with clean fill, and then covered by a geosynthetic clay liner.

scrap/waste wood. The building structure was removed prior to 2006. Because of the presence of a seep wetland feature and due to slope stability concerns, the concrete foundation for this structure was not removed during the summer of 2006.

An interim action involving the excavation of impacted soils from this area (Arcadis, 2008b) was completed in 2008. Impacted soils were removed, and clean, treated soils were backfilled into this area (Arcadis, 2010a). The interim action is discussed in further detail in Section 2.2.3.3.

1.2.1.4 Powerhouse and Fuel Barn AOI

The Powerhouse and Fuel Barn AOI is located directly north of Pond 8 (Figure 1-4). Former features in the area include the Dewatering Slabs, Equipment Fueling Area, Steam Dry Kilns, Former South Pond, Fuel Barn, Powerhouse Building, Transformer Pad, Oil Storage Shed, Chemical Storage Tank, Poly Tanks/Small Transformer Pad to the south, Paint Storage Shed, Fly Ash Reinjection System, Open Refuse Fire Area, and Cooling Towers (including the Poly Tank/Transformer Pad and the Cooling Towers Storage Shed). Features still present include the Concrete Lined Tank and Process Water Pumping Station.

During operation, the Powerhouse used residual wood chips from plant operations to generate power. During the last one to two years of the mill operations, municipal wood waste from offsite sources was used as fuel; fly ash was generated by the burning of this fuel. The Powerhouse had a concrete foundation and contained brick ovens, boilers, turbines, water pumps, and other associated equipment to generate power for site operations. Chemicals used and stored in the Powerhouse included: grease, solvent, filter oil, turbine oil, automatic transmission fluid, motor oil, trisodium nitrilotriacetate (a boiler feed water additive), and mercury (contained within switches). Review of site records indicates the presence of two hydraulic units (total containment: 100 gallons), one each on the north and south sides of the boilers on the fire deck area. Site documentation also indicated the presence of three turbine oil tanks (total containment: 2,100 gallons) beneath the floor grating between the east and west ends of the turbines. Several 1- and 5-gallon buckets of paint and a large pump were stored in a small wood shed with concrete flooring on the south side of the Powerhouse. Also, on the south side of the Powerhouse were two 330-gallon ASTs containing water and sodium hydroxide. A transformer was observed next to the ASTs (Figure 1-4).

The foundations of the Powerhouse and associated structures were demolished in August 2006. After the demolition, the area was covered with a wet cap in September 2006.

The Poly Tanks/Transformer Pad, Chemical Storage Shed, and Paint Storage Shed were located south of the Powerhouse Building. The Paint Storage Shed was constructed of wood with a concrete floor. The foundations of these structures were not removed during the foundation removal effort in 2006 (Arcadis BBL, 2007a).

Two transformer pads were located north of the Powerhouse. The larger pad was constructed of concrete and enclosed with a chain-link fence, while the smaller pad consisted of an open-sided shed southeast of the larger Transformer Pad. An Oil Storage Shed was located directly east of the larger Transformer Pad. The Oil Storage Shed had dimensions of approximately 15 by 20 feet, was constructed of wood and had a concrete secondary containment base with expanded metal grating. Plant personnel indicated that the shed was constructed in the late

1980s. The large and small transformer pads and the Oil Storage Shed north of the Powerhouse were broken up in July 2006.

The Cooling Towers were located south of the Powerhouse on the berm that separated the Powerhouse area from Pond 8 (Figure 1-4). The area consisted of the Cooling Towers, a small shed, and two concrete pads for poly tank storage. The Cooling Towers building (visible in the 1983 aerial photograph) was constructed and operational in the mid-1970s (according to plant personnel) and contained four cooling elements. The building had a concrete foundation and corrugated metal walls on the east and west sides. The north and south sides of the building were screened with metal slats. The small storage shed was located east of the Cooling Towers. According to site personnel, the shed was built in the mid-1970s and was constructed of corrugated metal on a concrete foundation. During the Phase I ESA (TRC, 2004a), ammonium chloride, sodium hypochlorite, and soda ash were noted as being stored in the shed. South of the shed were three poly tanks on a concrete pad. Chemicals stored in the tanks included sodium hypochlorite, isopropanol, and formula 222 (sodium molybdenum). All foundations in the Cooling Towers area were removed in August 2006, and a dry cap was placed in the removal area.

The Fuel Barn was located west of the Powerhouse. Historical photos, Sanborn maps, and interviews with site personnel suggest that the Fuel Barn was built prior to the early 1950s. The walls were constructed of corrugated metal, and the floor was composed of soil and mulch. There was a concrete “trench” in the center of the Fuel Barn, which was used to support a conveyor system. During plant operations, the “fuel” (wood chips) for the Powerhouse was stored in the Fuel Barn. A fuel digger, located in the Fuel Barn, moved the wood chips onto a conveyor belt and into the Powerhouse. The concrete stem wall foundation and center concrete structure at the Fuel Barn were removed in June 2006.

The Dewatering Slabs were located in the northwestern corner of the AOI near the North Pond (Figure 1-4) and were approximately 1,600 square feet (sf) in area and surrounded to the north, west, and south by a concrete containment berm. The slabs were constructed of concrete and were used until 1996 to dewater wet fly ash from the Powerhouse. Scrubber water from the boilers contained fly ash and was piped to the two dewatering slabs, where, after drying, the residual fly ash was placed in a dump hopper for removal and placement at an offsite location. Water on the dewatering slabs that did not evaporate was conveyed to Pond 7, and then pumped to Ponds 1 through 4 for further treatment. Use of the slabs was discontinued in 1996, when the Fly Ash Reinjection System was installed east of the Powerhouse (Figure 1-4). Following this installation, process water from the boilers was conveyed to Pond 7 and from there via an underground pipe to Ponds 1 through 4. Pond 4 was created in 1996 to receive water from Pond 7 and was dredged once or twice annually from 1996 to 2002; Pond 7 was dredged twice. The dredged material was placed in the former ash pile area located east of the Southern Ponds and removed in 2006. Ponds are discussed further in Section 1.2.2. The Dewatering Slab foundation and the northern portion of the Fly Ash Reinjection System building pad were removed in June 2006, and a dry cap was placed in the removal area. The Fly Ash Reinjection System pad foundation, located within approximately 15 feet of the retaining wall, was not removed.

1.2.1.5 Pond 8 (also known as the Log Pond or Mill Pond) Fill Area AOI

The Pond 8 Fill Area AOI comprises the land along the eastern, southern, and western perimeters of Pond 8 (Figure 1-4 and 1-7). Pond 8 originally extended further east and west. Portions of Pond 8 appear to have been filled between 1966 and 1998 (TRC, 2004a).

Prior to the construction of the Cooling Towers in the Powerhouse AOI (Section 1.2.1.4) such towers were located near the southwestern corner of Pond 8. According to plant personnel, the Cooling Towers at this location ceased operation and were subsequently demolished in the early 1970s. The former Cooling Towers location is currently undeveloped and consists of a concrete pad in a gravel area with some vegetation.

Additional Pond 8 fill areas were identified after review of historical aerials. Herein, these areas are termed Pond 8 Fill Area AOI – West, Pond 8 Fill Area AOI – South, Pond 8 Fill Area AOI – North, and Pond 8 Fill Area AOI – East. A summary of soil and groundwater samples collected in and near these fill areas as part of investigations for neighboring AOIs are presented in Table 1-1. There are approximately 74 sample locations in or near the four Pond 8 Fill Area AOI areas. Pond 8 Fill Area AOI – North in particular was evaluated as part of the cooling tower investigation in the Powerhouse and Fuel Barn AOI presented in the OU-E RI. Of these 74 sample locations, approximately two-thirds of the samples were subsurface samples collected at depths of 5 feet or greater (not shallow samples), which is similar to the samples collected as part of the Pond 8 Fill Area AOI investigation presented in the OU-E RI. The maximum depth of the remaining Pond 8 is approximately 13 feet below the water surface, and it is likely a reasonable assumption that the filled areas of Pond 8 were a similar or shallower depth to the remaining Pond 8. Therefore, many of the samples that have already been collected in or near the newly-identified Pond 8 Fill Area AOI areas are representative of Pond 8 fill. Some portions of the new Pond 8 Fill Area AOI areas have been approved for NFA as part of the Coastal Trail, and the other areas are currently being considered for NFA, as presented in the Community Update figure "Mill Site Soil and Sediment Status, May 2018" (DTSC 2018b). Altogether, sufficient data have been collected in the vicinity of the newly-identified Pond 8 Fill Area AOI areas, and investigation in these Pond 8 Fill Area AOI areas is complete.

1.2.2 Aquatic Areas of Interest

Ponds 1 through 9 and the North Pond range in size from 0.1 acre to 7.29 acres. The ponds were constructed for operational purposes, including management of wastewater from site operations, providing a source of water for firefighting, and use as a log pond. Pond 8 also provides stormwater management for runoff from the City. The historical use of the ponds was described in the *Preliminary Site Investigation Work Plan Operable Unit E – Onsite Ponds* (Arcadis BBL, 2007b). A schematic illustrating the flow between the ponds is provided in Figure 1-5.

1.2.2.1 Ponds 1 through 4 (Southern Ponds)

Ponds 1 through 4 (a total of 2.8 acres), collectively known as the Southern Ponds, were a series of treatment ponds related to the operation of the former Powerhouse (Figure 1-5). Based on aerial photos, Ponds 1 – 3 were constructed between 1973 and 1996. Ponds 1 through 4 were settling ponds that treated water received from Pond 7 (see Section 1.2.2.3). Pond 4 was created in 1996 to receive water from Pond 7 and was dredged once or twice annually from

1996 to 2002. The dredged material was placed in the former ash pile area located east of the Southern Ponds and removed in 2006. Figure 1-6 illustrates how the Southern Ponds changed over time. The Southern Ponds discharge to the southwest end of Pond 8 through a culvert system.

1.2.2.2 Ponds 5 and 9

Pond 5 (0.6 acres) was man-made for facility purposes. Pond 5 received water from Pudding Creek as well as runoff from the main office area (OU-B) and offsite runoff from Highway 1 (Figure 1-5).

Pond 9 (0.71 acres) is a man-made reservoir supplied by surface water pumped from Pudding Creek. Water from this pond was pumped to hydrants for firefighting. Water is not currently pumped to Pond 9 from Pudding Creek (Figure 1-5).

1.2.2.3 Pond 7

Pond 7 (0.13 acres) received effluent from the wet scrubbers operating in the former Powerhouse power plant (Figure 1-5). From approximately the mid-1970s up until 1996, fly ash emissions from the boilers were controlled by multi-cyclone collectors, followed by wet scrubbers. Scrubber water from the boilers contained fly ash and was piped to two dewatering slabs where, after drying the residual, fly ash was placed in a dump hopper for removal and placement at an offsite location. Water on the dewatering slabs that did not evaporate was conveyed to Pond 7, and then pumped to Ponds 1 through 4 for further treatment. Pond 7 also received water from the dewatering slabs and wash water from the Powerhouse as well as groundwater and surface water runoff from the Powerhouse area.

1.2.2.4 Pond 6 and North Pond

Pond 6 (0.17 acres) collects stormwater runoff during winter storm events and also receives discharge from the North Pond and drainage water from Parcel 2. When the plant was operational, water from Pond 6 (when full) would be pumped to Pond 7 and subsequently to Ponds 1 through 4 when full. There is also an overflow culvert in Pond 6 that allows discharge of stormwater to Fort Bragg Landing (Figure 1-5).

The North Pond (0.06 acres) was formerly used as a settling basin for water used during the operation of the hydraulic debarker. Water from surface runoff from the surrounding uplands to the north currently enters the North Pond via a culvert on its east side and discharges to Pond 6 via a culvert (Figure 1-5).

1.2.2.5 Pond 8

Pond 8 (7.3 acres), also known as the Log Pond, was created in the late 1800s by the damming of Alder and Maple Creeks (Figure 1-5). The size of Pond 8 has changed over time. Based on aerial photos, the earliest documented size of Pond 8 was approximately 13.23 acres, and minimal changes in pond size occurred until after 1966 when several fill operations occurred. Pond 8 is currently approximately 7.3 acres. Figure 1-7 illustrates how the extent of Pond 8 changed over time. Additional details about these modifications or historical Pond 8 maintenance dredging or fill are not documented in available site historical information. Pond 8 receives stormwater runoff as well as overflow from Pond 5. Water from Pond 8 discharges over the dam spillway to the beach adjacent to Fort Bragg Landing. The total contributing watershed to Pond 8 is approximately 417 acres, consisting of 190 acres (including Pond 8 itself) within the Mill Site property and 227 acres outside the Mill Site property (related to stormwater management for the City). Total direct rainfall to the surface of the pond is less than 2 percent (%) of the total inflow to the pond.

1.2.2.6 Riparian AOI (formerly associated with OU-D)

The Riparian AOI was moved from OU-D to be further assessed in the OU-E FS. This AOI consists of undeveloped, wooded land along the eastern boundary of Parcel 7 (Figure 1-3). A riparian wetland and perennial surface drainage are present in the northern end of the AOI, and a seasonal wetland ditch runs along the western perimeter of the AOI. Shallow, unpaved drainage ditches run from the Former Log Storage and Sediment Stockpile AOI into the ditch in the Riparian AOI. Three existing groundwater wells (FB-1 through FB-3) were identified in the wooded area along the east side of Parcel 7 during previous investigations. The locations of these wells are not known, and they are, therefore, not presented on figures in this FS. Remnants of a corrugated metal drainage pipe have been observed in the stream bed approximately midway in the north-south section of the drainage. A water supply well on the western edge of this AOI contained a pump connected to an aboveground plastic pipeline used to transmit water to the nursery in Parcel 9 (TRC, 2004a). Sanitary sewer lines run through the north end of this AOI. No other historical uses of this AOI have been identified.

1.2.3 Groundwater Areas of Interest

1.2.3.1 IRM AOI (formerly associated with OU-C)

The IRM AOI is located directly south of Pond 5 (Figure 1-3). The AOI was dominated by the Former Parcel 5 Mobile Equipment Shop (MES) and adjacent buildings, such as the Former Tire Shop, the Former Washdown Building, and the Former Fuel Storage and Dispenser Building. A truck wash pit was formerly located southwest of the Former Fuel Storage and Dispenser Building.

The Former Parcel 5 MES historically housed tanks containing petroleum solvent, acetylene, and oxygen. In addition, the Former Parcel 5 MES contained an old diesel dispenser, a former paint storage room at the northwestern corner of the building interior, a former oil change waste pit in the northern portion of the building interior, and a room that formerly housed an air compressor north of the fuel dispenser at the building exterior. Within the building were two sheds that were used for chemical storage, including lube oil, waste oil, used oil filters, transmission fluid, hydraulic fluid, grease, and antifreeze. At the time of AME's (2005a) additional investigation work, the west shed contained 1,100 gallons of tractor hydraulic fluid and 330 gallons of lube oil in the form of six 55-gallon drums. Prior to this, the shed contained four 27-gallon ASTs (three containing hydraulic fluid and one containing transmission fluid); five plastic and metal 55-gallon drums containing gear lube oil, used oil, waste-paint-related material, used oil filters, and lube oil; and two open 55-gallon drums, cut in half, that contained used oil, oil-stained cardboard, oil-stained spill pads, and booms. A concrete-lined pit covered by a perforated steel plate was also located in the shed. Water and sludge collected in the pit and were periodically removed. An AST was also formerly located just outside the southwest corner of the building. The Former Parcel 5 MES was demolished during the summer of 2007.

The Former Tire Shop was a 40-foot by 50-foot building located west of the southern end of the Former Parcel 5 MES. It was constructed between the late 1980s and early 1990s. Maps and photographic evidence from 1963 to 1982 show a different building in this location, but there are no records pertaining to its use (AME, 2005a). The Former Tire Shop was demolished during the summer of 2007.

The Former Washdown Building was located immediately southeast of the Former Parcel 5 MES and contained three sumps. One was located in the northwestern corner of the building, one near the center of the building, and another in the southern portion of the building next to the fuel island. A recycled AST was also located in this area. North of the building was an area with surface staining and a drainage area. The Former Washdown Building was demolished during the summer of 2007.

The Former Fuel Storage and Dispenser Building was the southernmost building in Parcel 5. It housed four ASTs that were used to store lube oil, unleaded gas, diesel, and waste oil. Piping from the northwestern corner of the Former Fuel Storage and Dispenser Building ran underground from the waste oil and lube oil ASTs northward along the west side and to the northwestern corner of the Former Parcel 5 MES. An additional covered trench for compressed air piping ran from the Former Fuel Storage and Dispenser Building to the Former Washdown Building. The piping entered the Former Parcel 5 MES and was formerly connected to an interior oil fuel dispenser adjacent to the former paint storage room. The Former Fuel Storage and Dispenser Building was demolished during the summer of 2007.

Southwest of the Former Fuel Storage and Dispenser Building was the location of the Former Truck Wash Pit. The 1981 plant drain map (Georgia-Pacific, 1981) shows an oil trap, sump, and wash rack in this area. The pit was open but is now backfilled. The Phase I ESA (TRC, 2004a) identified an oil trap in this area and there may have been a separator associated with the pit.

An interim action involving the excavation of impacted soils from this area (Arcadis, 2008b) was completed in 2009. Impacted soils were removed, and clean, treated soils were backfilled into this area (Arcadis, 2010a). The interim action is discussed in further detail in Section 2.2.3.4.

1.2.3.2 West of IRM AOI (formerly associated with OU-C)

The West of IRM AOI is bounded by the IRM delineation on the east, the OU-D delineation on the south, and the OU-E delineation on the west (Figure 1-3). It extends no further north than the IRM. An interim action (Arcadis, 2008b) completed in 2009 extended into this AOI. Impacted soils were removed, and clean, treated soils were backfilled into this area (Arcadis, 2010a). The interim action is discussed in further detail in Section 2.2.3.4.

1.3 Report Organization

The remainder of this FS is organized as follows:

Section 2: Conceptual Site Model summarizes the site setting, investigations and interim remedial actions, and the nature and extent of chemicals of interest (COIs) and chemicals of concern (COCs). Based on the nature and extent of COIs, terrestrial AOIs were grouped as “Lowland Terrestrial Soil” and groundwater AOIs were grouped as “IRM and West of IRM Groundwater” and “Lowland Groundwater.” Aquatic sediment AOIs were left as individual areas for further evaluation.

Section 3: Objectives and Requirements of Remediation presents the applicable or relevant and appropriate requirements (ARARs), remedial action objectives (RAOs), and cleanup goals established for the site.

Section 4: Areas and Volumes for Remedial Alternative Development provides an overview of general response actions (GRAs) that could potentially be used to meet the RAOs.

Section 5: Identification and Screening of Remedial Technologies and Process Options evaluates the effectiveness, implementability, and cost-effectiveness of potential technologies and screens for further analysis.

Section 6: Identification of Screening Criteria discusses the screening criteria utilized to evaluation remedial alternatives.

Section 7: Development and Evaluation of Remedial Alternatives summarizes approved remedial actions for the lowland terrestrial soil area and the aquatic sediment areas (Ponds 1 through 4 [Southern Ponds] and Pond 7), as presented in the OU-E RAW (Arcadis, 2016a); and develops remedial alternatives for the remaining aquatic sediment areas (North Pond and Pond 6 and Pond 8) and evaluates against the screening criteria. Remedial alternatives are compared and a preferred alternative is selected, per area.

Section 8: Summary of Recommended Remedial Alternatives summarizes the preferred alternative per AOI.

Section 9: References presents the references cited throughout the report.

Section 2: Conceptual Site Model

This section presents the conceptual site model (CSM) that describes the site setting, summarizes previous investigations and interim remedial measures, and provides an overview of the nature and extent of COIs. Chemicals that were identified as potential risk drivers in the BHHERA are termed chemicals of concern (COC) herein. The CSM is primarily based on data reported in the OU-E RI Report (Arcadis, 2013a), BHHERA (Arcadis, 2015b), *Remedial Investigation, Operable Units C and D* (OU-C and D RI Report; Arcadis, 2011a), and *Feasibility Study, Operable Units C and D* (Arcadis, 2012a). This updated CSM forms the basis for assessing soil and groundwater conditions at the site. As such, it summarizes the fundamental information required to assess the feasibility of potential remedial actions.

2.1 Site Setting

This section presents the site setting in terms of land use, ecology, climate, geology, hydrogeology, occurrence of groundwater, surface water hydrology, and cultural resources.

2.1.1 Land Use

Most industrial features within OU-E have been removed, with the exception of a few smaller features shown on Figure 1-4. With the exception of these remaining industrial features, OU-E is generally vacant. There are no active structures or uses in the terrestrial area and the primary use of the aquatic areas, specifically Pond 8, is to provide stormwater management prior to discharge to the ocean. While foundations of former buildings remain in certain portions of this area, there has been extensive investigation of these areas. Public coastal trails extending both north and south of Fort Bragg Landing were opened in 2014 and 2016, respectively. The northern and southern portions of the public coastal trail will be connected through OU-E in 2018. When complete, the trail corridor will be fenced by the City of Fort Bragg to exclude trespassing onto the remainder of the Mill Site. The foreseeable future use of OU-E is as continued stormwater management facilities, open space, and recreational trail development. The City's Land Use Plan is presented in Figure 2-1. The site is fenced and locked to restrict trespassers.

Environmentally sensitive habitat areas (ESHAs[4]) comprise approximately one-fifth of the OU-E lowland (Section 2.1.2) and approximately one-third of the remaining area.

[4] ESHAs are referred to as "environmentally sensitive habitat area[s]" in Section 30107.5 of the California Coastal Act and are defined as "any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments". ESHAs in OU-E include wetland and open water habitats. Regulatory protection of ESHAs in the California Coastal Zone ultimately falls under the jurisdiction of the California Coastal Commission (CCC). The City administers CCC Coastal Act jurisdiction for the site under their Local Coastal Program.

2.1.2 Ecology

The majority of OU-E, along with the IRM AOI and West of IRM AOI, was previously developed industrial land characterized by large areas covered with structures/foundations, asphalt, crushed rock, or a mixture of both. Weedy ruderal vegetation is occasionally observed in these areas (WRA Environmental Consultants [WRA], 2005).

Within OU-E, identified wetlands and waters include ponds and ditches used in former sawmill operations and seasonal wetlands[5], and wetland seeps[6] (Figures 2-2, 2-3, and 2-4). Most of the ponds at the site are dominated by species typical of freshwater marshes, although a few consist of open water with less than 5% cover by vegetation.

Two ESHA delineation efforts occurred to identify "any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments" (California Coastal Commission [CCC] definition; CCC, 2000). In 2009, WRA delineated 20 waters, including wetlands, totaling 13.31 acres, including Ponds 1 through 9 and the North Pond (classified as industrial ponds) and three wetland seeps on the vegetated slope of the northern portion of OU-E (Wetlands B, C, and D, shown on Figure 2-3; WRA, 2009).

In 2010, Arcadis identified three wetland seeps (the eastern portion of Wetland E-1, Wetland E-3, and Wetland E-8) and four seasonal wetlands in OU-E (the western portion of Wetland E-1, Wetland E-2, Wetland Complex E-5 and E-6, and Wetland E-7; Figure 2-3). One additional wetland classified as an industrial pond (Wetland E-4) was identified in a concrete-lined pit that was a remnant of a demolished building. Additional discussion of these areas is included in the *Environmentally Sensitive Habitat Areas Delineation Report* (Arcadis, 2011b).

2.1.2.1 OU-E Flora and Fauna

In 2005, WRA conducted a biological assessment (WRA, 2005) to identify potentially sensitive biological resources at the site. Non-sensitive plant communities identified at the site included developed industrial, non-native grassland, northern coastal bluff scrub, coastal strand, and planted coniferous woodland. Sensitive plant communities observed at the site included coastal terrace prairie, north coast riparian scrub, coastal and valley freshwater marsh, freshwater seep, riparian wetland, seasonal wetland, and seasonal wetland ditch.

The majority of the terrestrial portion of OU-E consists of industrial land characterized by large areas previously covered with structures/foundations, asphalt, crushed rock, or a mixture of both. Vegetation in these areas includes non-native annual grasses and weeds, including sow thistle *(Sonchus asper)*, wild radish *(Raphanus sativa)*, and Italian ryegrass *(Lolium multiflorum)*. Pampas grass (*Cortaderia selloana*), a common invasive species, grows in the terrestrial areas of OU-E.

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[5] Seasonal wetland plant communities occur in depressions that are inundated during the rainy season for sufficient duration to support vegetation adapted to wetland conditions.

[6] Freshwater seep plant communities are wetlands containing perennial and annual herbs, including sedges and grasses, which occur in areas that receive perennial or semi-perennial hydrological input as a result of subsurface flow of water.

Waters and wetlands identified in OU-E support a mix of native and invasive hydrophytes. Ponds at the site are dominated by species typical of freshwater marshes, which typically support perennial emergent monocots from 4 to 5 meters tall, often forming completely closed canopies (Holland, 1986). Ponds dominated by emergent vegetation at the site contained species such as water parsley *(Oenanthe sarmentosa)*, parrot's feather *(Myriophyllum aquaticum)*, slough sedge *(Carex obnupta)*, and cattail *(Typha latifolia)*. Plant species observed in seasonal wetlands present at the site include all flatsedge *(Cyperus eragrostis)*, purple velvet grass *(Holcus lanatus)*, common horsetail (*Equisetum arvense*), and California blackberry *(Rubus ursinus)*. Plant species associated with the freshwater seeps at the site include panicled bulrush *(Scirpus microcarpus)*, seep monkey flower *(Mimulus guttatus),* soft rush *(Juncus effusus)*, and common horsetail *(Equisetum arvense)*.

A variety of birds and mammals may occur within the boundaries of OU-E, including rabbits, deer, geese, raccoon, muskrat, mallard, egret, and heron. Killdeer (*Charadrius vociferous*) and marsh wren (*Cistothorus palustris*) may use the terrestrial area for nesting.

The ponds provide habitat for amphibians and aquatic plants and provide a food source for wildlife. The isolated nature of the ponds and some aspects of the physical configuration (e.g., pond banks are generally very steep, there is little open water, and/or water levels are low and turn anoxic in late summer/fall) limit the utility of the ponds to fish.

During the 2005 Biological Assessment, WRA (2005) recorded 54 special status species of wildlife in the site vicinity, indicating that appropriate habitat may exist on or near the site for each species listed, but that the species may not be present onsite, or that the species may spend little time onsite and not feed onsite. Only three special status species – the double-crested cormorant (*Phalacrocorax auritus*), the California brown pelican (*Pelecanus occidentalis californicus*), and the osprey *(Pandion haliaetus)* – have a high potential for occurrence in the site vicinity. The pelagic cormorant (*Phalacrocorax pelagicus*, not a special status species) has been observed nesting along the bluffs, but the double-crested cormorant has not. The pelican has been observed foraging offsite but has not been observed to visit the site itself. Osprey roost in trees on the bluffs and hunt offshore. These species do not nest onsite and are not expected to obtain a significant portion of their diet from the site.

WRA (2005) and Sholars (2005a and b) recorded 47 special status plant species in the site vicinity. Of the 47 special status plant species, 18 have a moderate potential to occur at the site, and only three sensitive plant species were found during the Sholars (2005a and b) botanical surveys: Blasdale's bent grass *(Agrostis blasdalei)*, Mendocino Coast Indian paintbrush *(Castilleja mendocinensis)*, and short-leaved evax *(Hesperevax sparsifolia* var. *brevifolia)*. None of these special status plant species are likely to occur within OU-E. Monthly surveys conducted in OU-E from February to May 2010 did not identify special status plant species in OU-E (Arcadis, 2011b).

2.1.2.2 OU-C Flora and Fauna (IRM AOI and West of IRM AOI)

The IRM AOI and West of IRM AOI, formerly associated with OU-C, are developed industrial land similar to the terrestrial portion of OU-E (WRA, 2009). The IRM AOI and West of IRM AOI are largely covered by asphalt, with occasional weedy ruderal vegetation such as sow thistle *(Sonchus asper)*, wild radish *(Raphanus sativus)*, and Italian ryegrass *(Lolium multiflorum)*. Where no concrete is present, soils are highly compacted and sometimes mixed with wood chips, with some areas dominated by subterranean clover *(Trifolium subterraneum)*, Italian ryegrass, and white clover *(Trifolium repens).*

Birds and mammals likely do not use the upland areas of OU-C, including the IRM AOI and West of IRM AOI, for foraging, nesting, or meeting other critical needs, as OU-C provides little to no habitat for these potential receptors.

2.1.2.3 OU-D Flora and Fauna (Riparian AOI)

Plant communities that occur within the Riparian AOI include planted coniferous woodland, north coast riparian scrub, riparian wetland, seasonal wetland and wetland ditch, and drainages. Although the wetland area in the Riparian AOI may provide some limited areas of suitable habitat for some aquatic-feeding species, such as the great blue heron, the Riparian AOI is not known to support populations or significant numbers of fish or macroinvertebrates to serve as a significant prey base for larger wildlife.

2.1.3 Climate

Western Mendocino County has a relatively mild climate with abundant rainfall. Temperatures remain cool throughout the year, with averages ranging from 53 to 57 degrees Fahrenheit (°F). At Fort Bragg, the difference in the average monthly temperature of the coolest month (January) and the warmest month (September) is only 8°F. Marine air minimizes the difference between daytime and nighttime temperatures; at Fort Bragg, the variation between the average high and low daily temperatures for August is 15°F (Natural Resources Conservation Service, 2002).

Precipitation levels vary from 35 to 80 inches per year, and precipitation 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.

Mean annual wind speed in the area is 7.3 miles per hour, and the prevailing wind direction is generally from the north to northwest in the summer and from the south in the winter (City, 2004).

2.1.4 Site Geology

2.1.4.1 Regional

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 of Cretaceous to Tertiary (late Eocene) age (40 to 70 million years old). The Franciscan Complex comprises a variety of rock types. In the north coast region, the Franciscan 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 Franciscan Complex, ranging in age from the Upper Jurassic to the late Cretaceous. The Coastal Belt consists predominantly of greywacke sandstone and shale.

Besides the Coastal Belt, other geologic units present in Fort Bragg and in the vicinity include surficial deposits of beach and dune sands, alluvium, and marine sediments. As discussed below, the most important of these at the site are the marine sediments, which cut bedrock surfaces along the coast and form much of the coastal bluff material overlying bedrock. Artificial fill (reworked native soil or imported material) is also prevalent at the site.

The surficial geology of the site and environs is depicted on Figure 2-5. The site is underlain by Quaternary (less than 1.5 million years old) marine sediments deposited in thicknesses up to 30 feet on wave-cut surfaces parallel to the coast (Blackburn Consulting, Inc., 2006). These surfaces were 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 marine sediments comprise poorly to moderately consolidated silts, sands, and gravels, and in some locations, are overlain by a 3- to 4-feet-thick mantle of topsoil or up to a 20-feet-thick layer of artificial fill (BACE Geotechnical, 2004). Both the topsoil and fill are generally relatively coarse in texture, ranging primarily from sandy silts to gravel. The marine sediments are also generally coarse, but appreciable thicknesses of finer materials are also found onsite. Beneath these Pleistocene materials are the Tertiary-Cretaceous rocks (approximately 65 million years old) of the Coastal Belt, composed of well-consolidated sandstone, shale, and conglomerate.

2.1.4.2 OU-E Specific

The shallow subsurface of the terrestrial portions of OU-E contains up to three lithologic units: artificial fill, marine sediments, and bedrock.

2.1.4.2.1 Artificial Fill

Soil borings, test pits, and potholes completed in the terrestrial portions of OU-E identified artificial fill in most areas. In general, the fill consists of reworked marine sediments with foreign materials. It can be generally characterized as coarse-textured material (silty sands to silty gravels), often containing wood chips, bark, ash, sawdust, brick, scrap metal, charcoal, and plastic. Fill thicknesses greater than 30 feet below ground surface (bgs) have been observed along the eastern edges of Ponds 6 and 8, but thicknesses on the order of 5 to 10 feet bgs are more common in the terrestrial areas and around the ponds in Parcel 7.

2.1.4.2.2 Marine Sediments and Bedrock

Marine sediments and bedrock underlie the artificial fill (where present) in OU-E. As with other portions of the site, Franciscan bedrock is present beneath the upland portions of OU-E but based on lithological information available from borings advanced at the site, its surface undulates and depths to bedrock can vary widely over short lateral distances. For example, within a 350-foot distance along the eastern edge of Pond 8, depths to bedrock vary from less than 10 feet bgs to greater than 40 feet bgs. Bedrock depths are generally shallow (approximately 10 feet bgs) near the ponds in Parcel 7, but in the formerly developed areas of Sawmill #1 and the Powerhouse, bedrock depths are generally no less than 30 feet bgs. In some locations around the margins of Pond 8, marine sediments are completely absent and artificial fill is in direct contact with bedrock.

2.1.4.3 OU-C and OU-D Specific (Riparian AOI, IRM AOI, and West of IRM AOI)

Similar to OU-E, the shallow subsurface of OU-C and OU-D contains up to three lithologic units: artificial fill, marine sediments, and bedrock. The artificial fill thickness has been measured up to 18 feet bgs within Parcel 5, which includes the IRM AOI and the West of IRM AOI. The Riparian AOI lies on the eastern edge of Parcel 7, where fill thicknesses are typically 10 feet bgs. Similar to OU-E, marine sediments and bedrock underlie the artificial fill in OU-C and OU-D. The bedrock surface has been observed to range between approximately 10 and 30 feet bgs.

2.1.5 Site Hydrogeology

2.1.5.1 Regional

The regional hydrogeologic setting of the Mendocino County coast has been presented in the Mendocino County Coastal Ground Water Study (California Department of Water Resources, 1982). The site is located 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, separated by the major rivers that discharge to the Pacific Ocean. The study included all areas where coastal terrace deposits had been mapped. The site is located within the Fort Bragg subunit, which extends from Big River to the south to Ten Mile River to the north.

Fresh groundwater is primarily obtained from shallow wells in the semi-consolidated 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.

2.1.5.2 Site Groundwater Occurrence and Hydraulic Properties

Based on quarterly monitoring from 2004 to 2012 and semi-annual monitoring from 2013 to the present, groundwater generally flows radially at the site toward Fort Bragg Landing and the Pacific Ocean (Figure 2-6) under average horizontal hydraulic gradients ranging from approximately 0.018 to 0.035 foot per foot (ft/ft; Arcadis, 2015a). Gradients are generally steeper in the central portion of the site and flatter in the northern and southern portions of the site. Depths to first-encountered groundwater have historically ranged from less than 1 foot to approximately 29 feet below top of casing (btoc). In terms of elevation, groundwater levels have ranged from approximately 7 to 104 feet relative to North American Vertical Datum of 1988 (NAVD88). Depending on the location, groundwater levels have been observed to fluctuate seasonally up to 12 feet with the seasons; elevations are higher in the winter and spring and lower in the summer and fall. During the September 2016 monitoring event, groundwater was encountered at depths that ranged from 4.70 to 12.60 feet btoc. Groundwater elevations ranged from 7.37 to 83.73 feet relative to NAVD88, which is consistent with historical trends (Arcadis, 2016b). Figure 2-6 provides the groundwater contour map based on water elevations measured in September 2017.

2.1.5.3 Groundwater Use

Groundwater is not currently used at the site. Groundwater in OU-E is generally relatively shallow. Unlike some upland areas of OU-C and OU-D where future use may be possible, most areas of OU-E, particularly all of the OU-E lowland, are close to the ocean and groundwater use may promote salinity and the potential to promote saltwater intrusion. Further, groundwater use in the OU-E lowland would dewater the existing groundwater-fed wetlands and wetland destruction in these areas would not be acceptable to applicable permitting agencies. Therefore, groundwater use for municipal or industrial purposes in OU-E is not expected, particularly in the shallow zones in the current monitoring program. The City of Fort Bragg only allows the use of groundwater for non-potable landscaping irrigation.

2.1.5.4 OU-E Lowland

Much of OU-E lies at the lowest elevations at the site and groundwater flow paths tend to converge in the areas around Fort Bragg Landing, with eventual discharge to the Pacific Ocean (Figure 2-6). Along an east-to-west cross-section through the terrestrial area of OU-E, average horizontal hydraulic gradients were on the order of 0.033 ft/ft during the September 2016 monitoring event (Arcadis, 2016b). Average horizontal gradients along the north-to-south direction of the radial flow paths were about double (on the order of 0.056 ft/ft). In September 2016, groundwater was encountered across OU-E at depths that ranged from 4.70 to 12.23 btoc. Groundwater elevations across OU-E ranged from 7.37 to 17.76 feet relative to NAVD88. Depths to groundwater of approximately less than 1-foot btoc have been recorded in the center of the area north of Pond 8 (monitoring wells (MW)-4.4 and MW-5.16), with depths along the eastern (monitoring well MW-5.18) and western perimeters (monitoring well MW-4.6) increasing to more than 12 feet btoc.

2.1.5.5 IRM AOI and West of IRM AOI

Across the IRM AOI and the West of IRM AOI, groundwater flows northwesterly toward OU-E under an average hydraulic gradient of 0.011 ft/ft (Figure 2-6). In September 2016, groundwater was encountered at depths that ranged from 7.32 to 13.51 btoc. Groundwater elevations across the IRM AOI and the West of IRM AOI ranged from 41.63 to 49.85 feet relative to NAVD88 (Arcadis, 2015a).

2.1.5.6 Riparian AOI

In general, groundwater flows northwesterly in the vicinity of the Riparian Area under average horizontal hydraulic gradients of 0.017 ft/ft (Figure 2-6). In September 2016, groundwater encountered at depths that ranged from 4.71 to 17.49 btoc. Groundwater elevations in the vicinity of the Riparian AOI (formerly associated with OU-D) ranged from approximately 39.86 to 83.73 feet relative to NAVD88 (Arcadis, 2016b).

2.1.6 Surface Water Hydrology

Figure 1-3 identifies the locations of 10 man-made ponds (Ponds 1 through 9 and the North Pond) ranging in size from 0.1 acre to 7.29 acres. The ponds served operational purposes, and Pond 8 also provides stormwater management for the City. Water transfer into and among the ponds was an integral part of the operational history of the site. Figure 1-5 provides a schematic illustration of surface water flow at the site. More information on use of the ponds during historical site operations appears in Section 1.2.2.

Most waters and wetland features (Section 1.2.2) rely on direct precipitation and surface water runoff. Some wetland seep features receive groundwater discharge as well. Waters and wetlands in this area lack a direct hydrologic surface connection to Fort Bragg Landing with the exception of Pond 6, which has a surface flow connection to Fort Bragg Landing via a corrugated high-density polyethylene (HDPE) culvert that discharges through the beach berm separating the OU-E lowland from Fort Bragg Landing. Runoff into the OU-E lowland also occurs from impervious surfaces (i.e., asphalt and concrete) in the higher elevation areas located to the north and east.

Pond 8, also known as the Log Pond or Mill Pond, was created in the late 1800s by the damming of Maple and Alder Creeks. Pond 8 receives stormwater runoff from the Mill Site, the City, and overflow from Pond 5. It is estimated that approximately 50 to 60% of the stormwater runoff entering the pond comes from the City, depending on storm conditions and magnitude (Arcadis, 2012b). Water from Pond 8 discharges over the dam spillway to the beach adjacent to Fort Bragg Landing.

In the past, the Southern Ponds (Ponds 1 through 4) received water from site operations. Currently, the Southern Ponds capture rainfall, stormwater runoff and some groundwater seeps. The bottom elevation of Pond 1 lies above the groundwater table, making Pond 1 seasonal and dry for a portion of the year. Ponds 2 and 4 are also seasonal, but have some groundwater input as the water table can rise above the pond bottom during the rainy season. The southeast and northwest portions of Pond 3 generally have groundwater infiltration year-round.

Pond 5 currently receives runoff from the main office area located to the north of the Pond. Pond 9 received surface water pumped from Pudding Creek to supply water to hydrants for firefighting.

2.1.7 Cultural Resources

TRC (2003, Undated #1, and Undated #2) conducted archival research and archeological surveys of the site and found that portions of the site are considered likely to contain intact prehistoric deposits, as well as historic sites. Areas that are likely to contain historic deposits are important in understanding the early settlement and development of the local community, as well as the lumber operations onsite.

Within OU-E, TRC identified moderate to high potential for prehistoric resources in the lowland terrestrial area. The area nearest Fort Bragg Landing was identified as having a high potential for prehistoric cultural resources. Although subsequent industrial activities may have destroyed prehistoric deposits near Fort Bragg Landing, the road and sea wall may have preserved possibly significant prehistoric cultural resources. OU-E was also identified as having high potential for historic resources. Historic buildings and infrastructure associated with past milling operations are found throughout the lowland terrestrial area (TRC, 2003).

No prehistoric sites were identified in the IRM AOI and the West of IRM AOI. TRC identified moderate potential for subsurface historic resources within the IRM AOI and the West of IRM AOI.

Within OU-D, the area identified by TRC that is considered to have a high potential to contain prehistoric cultural remains is the wooded area (Riparian AOI) on the eastern side of the site adjacent to the nursery. This AOI has been largely untouched by the industrial development that occurred on the other portions of the site. Most of the Riparian AOI was categorized as having moderate potential for historic resources, with the exception of a small area on the southwestern boundary of the Riparian AOI. This area may contain debris that may relate to earlier phases of lumber operations (TRC, 2003).

2.2 Investigations and Interim Remedial Actions

This section describes previous environmental investigations, biological assessment, interim remedial measures, remedial investigations, and risk assessments. The utilized dataset includes analytical results from the previous investigations described in the subsections below.

Investigation data collected prior to January 1998 were excluded as they have not been formally validated and have limited quality assurance/quality control information. Additionally, their age is a concern for characterizing current site conditions. Data from the investigations presented below were found usable, with the exception that additional data validation was required and completed for the data collected from January 1998 to March 2005, which did result in the qualification of a few analytical data points (Arcadis, 2010b). These data were used in the OU-E work plans (Arcadis BBL, 2007b and 2007c; Arcadis, 2010b, 2013b, 2014), OU-E RI Report, and BHHERA in order to adequately characterize the nature and extent of contamination in OU-E and associated AOIs (IRM, West of IRM, and Riparian AOIs formerly associated with OU-C and OU-D).

2.2.1 Environmental Investigations

This section summarizes environmental investigations conducted at the site relevant to OU-E, including lead-based paint (LBP) investigations, Phase I and Phase II environmental assessments, 2004 and 2005 additional site assessments, and groundwater monitoring. The sample identification nomenclature used in the investigations summarized in this section are summarized in Table 2-2.

2.2.1.1 Lead-Based Paint Investigation

In January 1998, TRC conducted a preliminary investigation of surface and shallow subsurface soil to evaluate paint on select buildings for elevated lead levels and to evaluate if chemicals associated with site operations were present in subsurface soil in the areas scheduled for demolition in Parcels 3, 4, and 5 (TRC, 1998).

2.2.1.2 Phase I Environmental Site Assessment

TRC performed a Phase I ESA of the site between 2002 and 2004 (TRC, 2004a). The Phase I ESA included visual inspections of each parcel; a site history survey, including historical Sanborn® maps, historical U.S. Geological Survey maps, and aerial photograph review; personal, telephone, and written communication with local and county regulatory agencies; interviews with current and past Georgia-Pacific employees with historical operational knowledge of the site; and a computer database search of sites with known environmental concerns within a 1-mile radius of the site.

As part of the Phase I ESA, Hygienetics Environmental Services, Inc. (Hygienetics) conducted an additional asbestos and LBP investigation in late 2002. Samples from the upland portion of OU-E were found to contain LBP in the Water Treatment Plant Building, the Chipper Building, Sawmill #1 Building, Compressor House 1, and the Powerhouse Building at concentrations up to 17,000 parts per million (ppm) lead (Hygienetics, 2003).

2.2.1.3 Phase II Environmental Site Assessment

TRC conducted a Phase II ESA to characterize site soils and groundwater in the AOIs identified in the Phase I ESA, and to refine the understanding of the nature and extent of affected media. Preliminary Phase II activities were conducted in March and April 2003. Supplemental Phase II activities were conducted in December 2003 and January 2004. The following field activities were completed at the site as part of this investigation

- Installation of seven monitoring wells within OU-E.
- A subsurface geophysical survey to identify the locations of suspected underground objects of interest, assess disturbed/fill areas, and to locate buried utilities.
- A soil assessment, including over 150 direct-push soil borings, nearly 70 potholes, and installation of 30 monitoring wells. Over 60 surface soil samples were also collected as part of this soil assessment. Grab groundwater samples were also collected from direct-push borings and the monitoring wells.
- An asbestos and lead based paint survey at 38 buildings/structures.

The results were presented in the Phase II ESA report (TRC, 2004b). Investigation areas included newly-identified Pond 8 Fill Area AOI areas, as discussed in Section 1.2.1.5. Samples collected in or near the newly-identified Pond 8 Fill Area AOI areas are summarized in Table 1-1[7].

2.2.1.4 2004 Additional Site Assessment

TRC conducted additional assessment activities pursuant to recommendations for follow-up assessment presented in TRC’s Phase I and Phase II ESAs. The additional site investigation included the completion of pothole investigations, geophysical investigation, and soil borings for the purpose of collecting additional soil samples, and to investigate surface anomalies and potential waste deposit areas. The results of the additional site assessment were presented in the *Additional Site Assessment Report* (TRC, 2004c).

2.2.1.5 2005 Additional Site Assessment

In 2005 and 2006, AME conducted additional site assessment work, including additional soil and groundwater sampling, geophysical surveys, and the installation of additional groundwater

[7] Sample locations are shown in figures presented in the Phase II ESA Report (Figures 8, 9, 12, and 13).

monitoring wells. Activities were conducted in general accordance with the *Work Plan for Additional Site Assessment* (AME, 2005a). The objectives are presented below:

- Evaluate the extent of impacts of chemicals of potential concern (COPCs) in site soil, ground water, surface water, and sediments[8];
- Investigate additional areas of concern identified subsequent to previous site investigation activities; and
- Characterize the site and provide representative concentration data for COPCs in soil, ground water, surface water, and sediments to support a risk-screening assessment and subsequent risk assessment work that considers both human health and ecological resources of concern.

Analytical data were reported in the *Dioxin Sampling and Analysis Report*[9] (AME, 2006a) and the *Data Transmittal Report* (AME, 2006b).

2.2.1.6 Pond Sediment Investigations

2.2.1.6.1 2008 Pond Sediment Investigations

Arcadis conducted pond sediment sampling activities in March 2008, as described in the *Data Summary Report, Operable Unit E Pond Sediment* (Arcadis, 2009). These activities were performed in general accordance with the *Preliminary Site Investigation Work Plan Operable Unit E – Onsite Ponds* (Arcadis BBL, 2007b). Sediment samples were collected from 26 locations in Ponds 1 through 9 and the North Pond. Sediment samples were collected from the intervals of 0 to 0.5 foot below sediment surface (bss) and 0.5 to 1.5 feet bss and analyzed for COIs for which a data gap had been identified: metals, TPH as diesel (TPHd), TPH as motor oil (TPHmo), PAHs, polychlorinated biphenyls (PCBs), and polychlorinated dibenzo-p-dioxin (dioxins) and polychlorinated dibenzofuran (furans). In some locations, samples were also collected at depths up to 9.5 feet bss. Sample locations were selected to characterize areas not previously addressed during historical investigations and/or to fill data gaps related to the spatial

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[8] Sample depths for samples collected as part of the 2005 Additional Site Assessment were measured with reference to the “pond water and plant debris” surface. Subsequent investigations measured sample depths with reference to the sediment surface. To discuss the results together in associated reports, sample depths for samples collected as part of the 2005 Additional Site Assessment were adjusted by the depths reported for the “pond water and plant debris” depth presented in Appendix D of the Dioxin Sampling and Analysis Report.

[9] The dioxin toxicity equivalency quotient (TEQ) values reported in the Dioxin Sampling and Analysis Report were calculated using the 1997 International Toxic Equivalent Factors (ITEF), as noted in Table 2 of the Dioxin Sampling and Analysis Report. However, the World Health Organization (WHO) published new Toxic Equivalent Factor (TEF) values in 2005, which have since been adopted by the Federal Environmental Protection Agency (EPA), California EPA, and DTSC (see HERO HHRA Note Number: 2; DTSC HERO, 2017), as well as this project. Therefore, dioxin TEQ values presented in the Dioxin Sampling and Analysis Report were recalculated using the 2005 WHO TEF values; the revised values were presented in subsequent reports. Note that the recalculated dioxin TEQ values did not increase or decrease by a consistent value due to variation in dioxin congener TEF values and dioxin congener concentrations.

and vertical distribution of specific COIs. Pond sediment sampling locations are shown on Figures 2-7 through 2-9.

2.2.1.6.2 2009 Mill Pond (Pond 8) Additional Sediment Investigation

An additional sediment sampling event was conducted in June 2009 to understand the magnitude and spatial extent of the COIs in Pond 8, to provide samples for sediment bioassay and bioaccumulation studies, and to provide paired data for estimation of site-specific bioaccumulation factors. Sample methods and results are described in full in the *Data Summary Report – Additional Investigation Pond 8 Sediment* (Arcadis, 2011c).

Because surface sediment (0 to 0.5 foot bss) was identified as the primary exposure media for Pond 8 (Arcadis BBL, 2007b and Arcadis, 2009), the investigation focused on surface sediment only. For this investigation, nine sediment samples were collected from Pond 8 and one sample was collected from Pond 9 to provide a basis for comparison for the Pond 8 sediment results, as Pond 9 has no known associated sources of site-related contaminants. Samples were analyzed for metals, TPHd, TPHmo, and dioxins and furans, as well as bioassay and bioaccumulation testing (Arcadis, 2011c). Pond sediment sampling locations are shown on Figures 2-7 through 2-9.

2.2.1.6.3 2012 Mill Pond (Pond 8) Geotechnical and Chemical Investigation

In February and March 2012, Arcadis conducted a sediment volume survey, and geotechnical and chemical investigation of Pond 8 sediments to further evaluate cleanup and restoration options. To further characterize sediment volume, the surface area of the pond was manually probed at recorded coordinates, and later integrated over the surface area of the pond to estimate a total of 106,000 cubic yards (cy) of sediment in the pond (Arcadis, 2012b). Sediment samples were collected and analyzed for metals and dioxins and furans. Pond sediment sampling locations are shown on Figure 2-7.

Samples were also collected for geotechnical characterization. Results indicated that Pond 8 sediment is generally classified as silty sand with an organic content between 20 and 50% and a hydraulic conductivity ranging from $1x10^{-7}$ to $4x10^{-7}$ centimeters per second, which is lower than what is typically observed for silty sand. Additionally, the total porosity is higher than what is typically observed for silty sands, suggesting that the sediment also has many clayey characteristics (Arcadis, 2012b).

The distribution of sediment thickness across Pond 8 and a cross-section of Pond 8, including both water and sediment depth and COC concentrations, is presented in Figure 2-10 through Figure 2-16. A statistical summary of the chemicals detected in Pond 8 was presented in the OU-E RI; the summary table is provided in Appendix B for reference. The maximum concentration of dioxin TEQ in Pond 8 is 243 picograms per gram (pg/g) and the exposure point concentration (EPC) in the 0 – 2 feet bss range is 110 pg/g. The EPC is the concentration of a constituent of potential concern (COPC) in an environmental medium to which a potential receptor might be exposed. For dioxin TEQ, a conservatively based 95% upper confidence limit (UCL) on the arithmetic mean concentration was estimated using USEPA's ProUCL 4.1 software to represent the EPC, as described in the BHHERA. The EPC is then compared to the applicable remedial goal or used to calculate risk estimates.

2.2.1.6.4 2013 Baseline Human Health and Ecological Risk Assessment Porewater Investigation

Additional sampling activities completed in 2013 followed methods presented in the OU-E BHHERA Work Plan (ARCADIS 2013b). The purpose of the OU-E BHHERA sampling activities was to evaluate the bioaccessible fraction of arsenic in OU-E sediment for potential human health receptors and to measure partitioning of metals and PAHs in OU-E and Riparian AOI sediment to porewater. Data collection activities included the collection of surface sediment samples for analysis for arsenic speciation and total arsenic, alkylated PAHs (bulk sediment and porewater), total organic carbon (TOC), black carbon, and pH and the collection of porewater samples for analysis for metals, major cations and anions, and alkalinity.

Sediment data were used, along with historical site data sets, in the evaluation of human health and ecological risk in the human health risk assessment (HHRA). Porewater data were used in the ecological risk assessment (ERA) to assess potential risk to benthic invertebrates exposed to metals partitioning from sediment to porewater. Results of these investigations are presented in the BHHERA (ARCADIS 2015b) and indicate that the mobility of chemicals of potential concern (COPCs) from the highly organic sediments to porewater is limited. ERA results for ponds evaluated individually indicate potential risk is not likely and the BHHERA ultimately concluded that unacceptable risks are not expected for populations of plants, benthic organisms, amphibians, birds, or mammals exposed to COPCs in sediment.

2.2.1.7 Groundwater Monitoring

Quarterly groundwater monitoring at the site was initiated by TRC in 2004. The monitoring network has varied over the years and is currently consistent with Comprehensive Monitoring Program (CPM) Update Number 6 (CMP Update No. 6; Arcadis, 2013c) as approved by DTSC in November 2013 (DTSC, 2013). CMP Update No. 6 includes the gauging of 18 groundwater monitoring wells (six of which are located in OU-E) and sampling of 17 groundwater monitoring wells (five of which are located in OU-E). The comprehensive groundwater monitoring dataset for the site, including all data collected through the first quarter of 2015 from active groundwater monitoring wells, is presented in the *First Semi-Annual 2015 Groundwater Monitoring Report* (Arcadis, 2015a).

2.2.2 Biological Assessment

In 2005, WRA conducted a biological assessment at the site to identify biological resources at the site. A total of 54 special status species of wildlife were recorded in the site vicinity, but only three special status species (the double-crested cormorant, the California brown pelican, and the osprey) have a potential for occurrence in the site vicinity. 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 the site. A total of 47 special status plant species were identified in the site vicinity, 18 of which have a moderate potential to occur at the site. Three sensitive plant species were found onsite during the botanical surveys: Blasdale’s bent grass, Mendocino Coast Indian paintbrush, and short-leaved evax; however, none of these special status plant species are likely to occur within OU-E and monthly surveys conducted in OU-E from February to May 2010 did not identify any special status plant species (WRA, 2005, updated 2007).

ESHA delineation activities were conducted by WRA in 2009 and Arcadis in 2010 to identify potential ESHAs (including potential federal and state jurisdictional waters, including wetlands [waters/wetlands]) located onsite. WRA (2009) delineated 20 waters/wetlands totaling 13.31 acres in OU-C, OU-D and OU-E. Of these delineated areas, 8.89 acres were classified as U.S. Army Corps of Engineers (USACE) jurisdictional waters/wetlands. Approximately 308 acres of the 317 acres that Georgia-Pacific owns were considered non-jurisdictional for USACE purposes. In 2010, Arcadis identified and delineated the following additional features as potential ESHAs: 17 waters/wetlands totaling approximately 3.64 acres, approximately 2.21 acres of riparian area, and approximately 375 linear feet of bedrock groundwater seep complexes. Arcadis also delineated coastal waters associated with Fort Bragg Landing. In total, there are 48 potential ESHA areas totaling approximately 19.16 acres of the approximately 317-acres comprising OU-C, OU-D and OU-E (Arcadis, 2011a). Delineated ESHAs within OU-E are shown on Figures 2-2, 2-3, and 2-4.

In 2010, Arcadis conducted a functional assessment of the delineated potential waters/wetlands to evaluate their ecological function. Arcadis followed guidance provided in *California Rapid Assessment Method (CRAM) for Wetlands* (Collins et al., 2008). Overall CRAM scores indicate that waters/wetlands evaluated on the site possess between 33 and 58% of the total functional capacity that a reference wetland system could attain. These CRAM scores indicate the generally degraded character of the site waters/wetlands. Ponds on the site scored lowest in the CRAM evaluation (i.e., between 32 and 45% of total functional capacity). Seasonal and seep wetlands that have developed in the OU-E lowland since demolition of the building foundations in this area scored the highest in the CRAM evaluation (i.e., 58% of total functional capacity). The complete results of the CRAM evaluation are presented in the *Mill Pond Complex Restoration Draft Conceptual Design* (Arcadis, 2011d).

2.2.3 Interim Remedial Measures

IRM activities as described in the *Interim Action Remedial Action Plan* (IARAP; Arcadis, 2008b) and *Interim Action Completion Report* (Arcadis, 2010a) were initiated in 2008 and completed in 2009. IRM activities include:

- Foundation removal and cap placement
- Excavation of former fuel pipe that extended from the former Fuel Storage Shed to the Powerhouse
- Excavation and disposal of soil impacted with metals near the former Compressor Houses
- Excavation and onsite treatment of TPH-affected soil near the former Compressor Houses
- In-situ groundwater treatment for TPH (biosparging and addition of oxygen-releasing material [ORM] before backfilling) near the former Compressor Houses
- Excavation and onsite treatment of TPH-affected soil within the IRM AOI and the West of IRM AOI

- In-situ groundwater treatment for TPH (biosparging and addition of ORM before backfilling) within the IRM AOI and the West of IRM AOI.

Approximate capped areas in the OU-E Lowlands are presented on Figure 1-4.

2.2.3.1 Foundation Removal

Concrete slab and foundation demolition activities were conducted in 2006. Following foundation removal, confirmation soil samples were collected in accordance with approved work plans (AME, 2005a,b,c). Caps consisting of geotextile membranes and crushed concrete, rock, and/or soil fill were placed in areas where foundations had been removed, as illustrated on Figure 1-4. Details regarding the demolition, investigation, and removal activities performed and the analytical results from the sampling are presented in the *Construction Completion Report* (Arcadis BBL, 2007a). Additional details regarding the caps and their design and construction are provided in the Final Cap Design Memorandum, included as Appendix G of the *Construction Completion Report* (Arcadis BBL, 2007a).

2.2.3.2 Pipeline Removal

In 2007, Arcadis removed a 4-inch-diameter, double-walled fiberglass fuel oil pipeline that extended south of the Powerhouse Fuel Storage Shed in a general southward direction across Parcel 4 to the Powerhouse (Arcadis, 2008a). The fuel oil line historically transported Bunker C fuel oil (also referred to as No. 6 fuel oil), a highly viscous long-chain or heavy oil used in boiler/combustion operations produced by blending long-chain residual oils with light oil, typically No. 2 fuel oil. The fuel oil was delivered by rail car, unloaded, and pumped to two steel ASTs. These tanks, located on the south side of the Powerhouse Fuel Storage Shed, were in operation from the 1950s to 1995, when they were decommissioned and demolished.

The pipeline excavation was completed in the north and south directions, well short of the Powerhouse to the south and the Fuel Storage Shed to the north, because the pipes had extended aboveground at these points to previously demolished overhead pipe racks. Overall, approximately 200 linear feet of the pipeline and 3,000 cy of soil were removed within the excavation boundary shown on Figure 2-17. The excavation of the fuel oil pipeline was completed on 21 June 2007.

2.2.3.3 Interim Action Compressor House Area

Metals and TPH-impacted soils were excavated from the Compressor House area in the summer of 2008. Approximately 60 cy of metals-impacted soil was excavated and transported offsite. Excavation of TPH-impacted soil at the Compressor House area was initiated following completion of the metals-impacted soil excavation. The total excavation area measured approximately 7,000 sf and 2,600 cy of soil were removed and transported to the land treatment unit for bioremediation (Arcadis, 2010a). Excavation proceeded to the south until a retaining wall was reached. Excavation boundaries are shown on Figure 2-18.

The excavation was advanced to at least 2 to 3 feet below the water table; groundwater that infiltrated into the excavation was treated by biosparging. Oxygen-releasing material was added to the backfill soil to address residual TPH contamination in soil and downgradient groundwater that may not have been affected by biosparging. Confirmation soil samples were collected from the walls and floor of the excavation, and samples were collected from the groundwater in the excavation prior to and following the biosparging. These results are presented in the *Interim Action Completion Report, Operable Units C and E* (Arcadis, 2010a).

2.2.3.4 Interim Action IRM AOI and West of IRM AOI

Between 2008 and 2009, four separate excavations were conducted within the IRM AOI and the West of IRM AOI to remove TPH-impacted soil. Excavation activities are presented in the *Interim Action Completion Report, Operable Units C and E* (Arcadis, 2010a). The excavation boundaries are presented on Figure 2-18 and the locations are described below:

- MES Upgradient Area – a subsection of the Former MES Area within the IRM AOI, which included the Former MES Building. This area was separated from the MES Road Area by a shallow soil berm, due in large part to logistical reasons (e.g., timing of the excavation completion, availability of equipment and personnel, etc.). The northern half of this area was excavated in 2008, and excavation of the southern half was completed in 2009. At the end of field work in 2008, the total excavation area measured approximately 18,250 sf, and another 17,550 sf were excavated in 2009 (Figure 2-18). Approximately 5,050 cy of soil were removed in 2008 and 5,700 cy of soil were removed in 2009. All excavated soil was transported to the land treatment units for bioremediation. The final excavation depths ranged from 4 to 14 feet bgs (Arcadis, 2010a).

- MES Road Area – a subsection of the Former MES Area expanding across the IRM AOI, West of IRM AOI and the Miscellaneous AOI, including the section of road running through Parcel 5 from Pond 5 to the southern end of the Former MES Building. The excavation, which was completed in 2008, was separated from the MES Upgradient Area by a shallow soil berm. The final excavation area was approximately 18,000 sf, with approximately 7,400 cy of soil removed (Figure 2-18). Excavation depths ranged from 5 to 13 feet bgs. The excavated soil was transported to the land treatment unit for bioremediation. Due to safety concerns related to maintaining an open excavation in high traffic areas, the entire MES Road Area excavated in 2008 was backfilled with bioremediated soils from the landfarm following completion of groundwater treatment. Prior to backfilling, sidewalls were covered with plastic sheeting to separate the clean backfill material from contaminated areas that were to be excavated in 2009 (Arcadis, 2010a).

- MES R53 Area – a shallow polygon located south of the Former MES Building. This small excavation was started and completed in 2009. Excavation of TPH-impacted soil at the MES R53 Area comprised an area of 65 feet by 75 feet (about 4,875 sf) and reached depths of 2 to 2.5 feet bgs (Figure 2-18). The total volume of excavated soil was approximately 400 cy, which was transferred to the land treatment units for bioremediation (Arcadis, 2010a).

- West of MES Area – excavation including the northern half of the West of IRM AOI, as well as a small portion of the IRM AOI and the Miscellaneous AOI. This area was addressed in 2009. The excavation area was directly adjacent to the western side of the 2008 MES Road Area excavation, and residual TPH-impacted soil left in place at the end of the 2008 season was removed. Pond 8 limited the western wall of the West of MES excavation; an approximately 20-foot barrier was left to avoid impacting the stability of the pond wall. The remaining TPH-d along the barrier ranges between 160 to 3,700 milligrams per kilogram (mg/kg) at 9 to 9.5 feet bgs. Excavation progressed north to remove impacted soil. The West of MES excavation measured approximately 58,000 sf, with approximately 21,000 cy of soil removed and transported to the land treatment units for bioremediation (Figure 2-18). The final excavation depths ranged from 8 to 10 feet bgs (Arcadis, 2010a). Based on confirmation sampling, the remaining TPH-d concentrations (maximum 3,700 mg/kg) are below the direct contact and indoor air unrestricted use remedial action goals of 10,772 mg/kg (aliphatics) and 4,220 mg/kg (aromatics) and, therefore, additional remedial work is not necessary in this area.

The planned excavation depth at all locations except for the MES R53 Area was extended at least 2 feet below groundwater so that groundwater would infiltrate the excavations and could be treated with biosparging and application of ORM. The ORM was added to the backfill soil to address residual TPH contamination in soil and downgradient groundwater that may not have been affected by biosparging (Arcadis, 2010a).

2.2.4 Remedial Investigations

In June 2010, additional sampling was conducted at OU-E in accordance with the *Site Investigation Work Plan, Operable Unit E – Upland* (Arcadis, 2010b) in preparation of the OU-E RI Report. In October 2010, Arcadis evaluated the existing historical site data and the June 2010 sampling data and identified data gaps that required step-out sampling to fully delineate chemical impact (Arcadis, 2010c). Additional step-out sampling was conducted in November and December 2010 (Arcadis, 2011e). Comprehensive analytical results were discussed in the RI Report to characterize the nature and extent of impacts (Arcadis, 2013a).

A screening level analysis for unrestricted use, including potential residential receptors, was conducted in the DTSC approved RI Report and exceedances of the unrestricted residential screening levels were identified (Arcadis, 2013a). Figures 2-19, 2-20, and 2-21 present comparison of lead, benzo(a)pyrene (B(a)P) TEQ, and dioxin TEQ in soil with human health preliminary screening levels (PSLs), respectively. Figures 2-22 and 2-23 present a comparison of arsenic and dioxin TEQ in Ponds 6, 7, 8, and North Pond with human health PSLs, and Figures 2-24 and 2-25 present a comparison of arsenic and dioxin TEQ in the southern ponds with human health PSLs, respectively. Figure 2-26 presents a comparison of dioxin TEQ in the Riparian Areas with human health PSLs.

Conclusions from the RI Report are summarized below, as discussed per AOI in Section 2.3 (alongside the refined conclusions from the BHHERA). These include constituents detected at concentrations greater than human health and/or ecological PSLs appropriate for unrestricted land use. The table summarizing human health risks from the BHHERA is provided as Table 2-1, herein.

- OU-E Lowland Terrestrial Soil: metals (antimony, arsenic, barium, chromium, copper, lead, mercury, molybdenum, and zinc), TPHd, polychlorinated dibenzo-*p*-dioxin/polychlorinated dibenzofurans (dioxins/furans), and PAHs were detected at concentrations greater than PSLs.
- OU-E Aquatic Area Sediment: metals (arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, and zinc), PAHs, volatile organic compounds (VOCs), dioxins/furans, PCBs, pesticides, and TPH were found at concentrations greater than PSLs.

- OU-E Groundwater: Metals (arsenic, barium, cobalt, copper, lead, molybdenum, nickel, thallium, and vanadium), PAHs, VOCs, dioxins/furans, PCBs, and TPH were found at concentrations greater than PSLs.

The RI Report recommended four of the five lowland terrestrial AOIs (Water Treatment and Truck Dump AOI, Sawmill #1 AOI, Compressor House and Lath Building AOI, and Powerhouse and Fuel Barn AOI) for further evaluation in the BHHERA. The RI Report recommended no further action (NFA) for the Pond 8 Fill Area AOI, due to only a single zinc exceedance of the ecological PSL and no exceedances of human health PSLs. All ten OU-E aquatic AOIs (Ponds 1 through 9, and the North Pond) were recommended for further evaluation in the BHHERA. The additional site investigation and risk assessment activities conducted for the BHHERA are further discussed in Section 2.2.6.

The OU-C and OU-D RI evaluated the nature and extent of constituents in the IRM and West of IRM AOI and assessed the risk associated with soil and groundwater conditions, as detailed in Section 2.2.5. The Riparian AOI was further evaluated during the investigation that accompanied the BHHERA. The purpose of the investigation was to provide a baseline human health and ecological risk assessment for OU-E and associated AOIs, which included the Riparian AOI. The COIs in the Riparian AOI that were investigated were metals (arsenic, barium, selenium, vanadium, and zinc) and PAHs (Arcadis, 2015b). The nature and extent of constituents considered in the BHHERA are presented in Section 2.2.6. No additional investigation of dioxin in soil or sediment was conducted as part of the BHHERA investigation for the Riparian AOI (DTSC, 2016).

2.2.5 OU-C and OU-D IRM and West of IRM Soil and Groundwater Investigations and Risk Assessment

In accordance with the IARAP (Arcadis, 2008b), soil excavation and in-situ groundwater treatment (biosparging and application of ORM) were conducted between 2008 and 2009 in the IRM and West of IRM AOIs. COI concentrations in non-excavated soil are generally below the screening levels. Slightly elevated TPHd concentrations remain in soil beneath the excavation area northwest of the MES and the excavation boundary in the vicinity of the Former Diesel AST (Arcadis, 2011a).

The BHHERA evaluation provided in the DTSC approved OU-C and OU-D RI concluded that COI concentrations in soil at the IRM and West of IRM AOIs do not pose a risk to human health or the environment. The IRM and West of IRM AOIs were recommended for evaluation in this FS for fuel-related constituents, VOCs, and arsenic in groundwater (Arcadis, 2011a).

2.2.6 OU-E Baseline Human Health and Ecological Risk Assessment

The RI Report and BHHERA were completed for the IRM and West of IRM AOIs as part of the OU-C and OU-D RI (Arcadis, 2011a) and are not further discussed in this section. This section presents the nature and extent of constituents for the Riparian AOI based on additional sediment and porewater samples collected from the Riparian AOI as part of the OU-E BHHERA investigation.

In April 2013, additional sediment and porewater samples were collected from Ponds 1 through 9, the North Pond, and the Riparian AOI (Figures 2-27, 2-28, 2-29, and 2-30). Data collected in the additional BHHERA investigation were used in conjunction with RI data to provide an evaluation of potential risk in OU-E for reasonably anticipated future receptors, based on current land and assumed future land use presented in the *Mill Site Specific Plan* (Mill Site Coordinating Committee, 2012; Figure 2-1). Human receptors evaluated in the terrestrial exposure area of OU-E included construction workers, maintenance/utility workers, passive (occasional) child and adult recreational visitors, frequent adult recreational visitors, and commercial/industrial workers (Figure 2-31). Human receptors in the combined aquatic exposure areas of OU-E included passive child and adult recreational visitors (Figure 2-32).

The OU-E BHHERA estimated exposure and characterized potential ecological risk in accordance with the CSM presented in the OU-E BHHERA and methods described in the *Site-Wide Risk Assessment Work Plan* (Site-Wide RAWP; Arcadis, 2008c) and the OU-E BHHERA Work Plan (Arcadis, 2013b). The BHHERA calculated EPCs for each COPC in each exposure area to inform the risk assessment. The EPC is the concentration of a COPC in an environmental medium to which a potential receptor might be exposed. The method of calculating the EPC varied based on the quantity of available data, as described in the following sections. A conservatively based 95% upper confidence limit (UCL) on the arithmetic mean concentration was estimated using USEPA's ProUCL 4.1 software to represent the EPC where sufficient data was available. ProUCL uses the maximum concentration when a 95% UCL cannot be calculated because of the data distribution. The EPC is then compared to the applicable remedial goal or used to calculate risk estimates.

Results of the OU-E BHHERA and hot-spot/residual risk and hazard analyses for the Lowland Terrestrial AOC, the Aquatic AOC, and the Riparian AOI are summarized in the following sections. The human health risk for each AOI, as presented in the OU-E BHHERA, is re-presented in Table 2-1.

2.2.6.1 Lowland Terrestrial AOI Risk Assessment

The BHHERA for the Lowland Terrestrial AOI included four of the five terrestrial AOIs (Water Treatment and Truck Dump AOI, Sawmill #1 AOI, Compressor House and Lath Building AOI, and Powerhouse and Fuel Barn AOI). In response to DTSC comments on the BHHERA work plan, and due to the absence of COPCs above relevant screening levels, the Pond 8 Fill Area AOI was not included as part of the BHHERA dataset.

The risk-based-target levels (RBTLs) used to identify presumptive remedy areas (PRAs) in the Lowland Terrestrial AOI were calculated and presented in the DTSC Human and Ecological Risk Office (HERO) memorandum, dated 25 June 2014. In that memorandum, site-specific risk-based soil concentrations targets for specific chemicals were developed, and they represent acceptable EPCs as 95% upper confidence levels (UCLs) on the arithmetic mean (identified as RBTLs in this FS). These RBTLs were multiplied by three to estimate not-to-exceed soil values, which are:

- 0.90 mg/kg for B(a)P equivalents (TEQ)
- 160 picograms per kilogram (pg/kg) or parts per trillion (ppt) for dioxin TEQ
- 320 mg/kg for lead.

All data points in the terrestrial AOI were compared to those ceiling concentrations. Data points at or above those ceiling concentrations were identified, and those locations were designated as hot spots or PRAs. After the removal of those identified data points, the residual EPCs were calculated from the remaining data points and compared to acceptable EPCs, i.e., RBTLs. After the presumptive remedy is completed, confirmation sampling confirmed that remaining sample data points do not exceed these ceiling concentrations (Kennedy/Jenks, 2018). Within the Lowland Terrestrial AOC, the following hot spots were identified for the following constituents in the vicinity of the indicated locations:

- B(a)P Equivalents (Figure 2-33):
  - Powerhouse and Fuel Barn AOI – Removal Action Area (RAA)-B1: one sample location (HSA-4.3 from 2 to 2.5 feet bgs)
  - Sawmill #1 AOI – RAA-B2: four sample locations (OUE-DP-073 from 2 to 3 feet bgs, OUE-DP-074 at 2 to 3 feet bgs, OUE-DP-075 from 2 to 3 feet bgs, and OUE-DP-026 from 2 to 3.5 feet bgs)
  - Waste Treatment and Truck Dump AOI – RAA-B3: two sample locations (OUE-DP-099 from 0.5 to 1.0 foot bgs and OUE-DP-100 from 2.5 to 3.5 feet bgs).
- Dioxin TEQ (Figure 2-34):
  - Powerhouse and Fuel Barn AOI – RAA-D1: one sample location (DP-052 from 0 to 0.5 foot bgs and 0.5 to 1.5 feet bgs).
- Lead (Figure 2-35):
  - Sawmill #1 AOI – RAA-L1 and RAA-L2: two sample locations (OUE-DP-070 from 3 to 4 feet bgs and DP-05.57 from 0.5 to 1 foot bgs)
  - Powerhouse and Fuel Barn AOI -- RAA-L3, RAA-L4, RAA-L5, RAA-L6, and RAAL7: five sample locations (OUE-DP-094 from 5.5 to 6 feet bgs, OUE-DP-090 from 5.5 to 6 feet bgs, OUE-DP-088 from 6 to 7 feet bgs, OUE-HA-023B from 6.5 to 8 feet bgs, OUE-DP-076 from 6 to 7 feet bgs and 8 to 9 feet bgs, and P4-40 from 6.5 to 7 feet bgs).

These hot spots were identified for removal in the OU-E Remedial Action Work Plan (RAW) (Arcadis 2016a). No hot spots were identified in the Compressor House and Lath Building AOI. Hot spots were identified in the remaining three terrestrial AOIs (Powerhouse and Fuel Barn AOI, Sawmill #1 AOI, and the Waste Treatment and Truck Dump AOI).

Residual B(a)P equivalents, dioxin TEQ, and lead EPCs (i.e., the 95% UCL on the arithmetic mean) were calculated excluding the identified hot spot concentrations to assess residual risks and hazards assuming hot spot removal. The BHHERA demonstrated that residual concentrations assuming hot spot removal in Lowland Terrestrial AOCs were below the RBTLs identified by DTSC (2014) for the current and reasonable likely future land uses.

Petroleum related constituents (TPHd) were detected above human health screening levels in one location. The overall human health risk for petroleum related constituents based on EPCs is acceptable. One location (OUE-DP-025, 12,634 mg/kg) slightly exceeds the human health screening level of 10,772 mg/kg and was not identified as a human health hot spot based on the limited risk relative to the human health PSL. This location was identified for removal in the OU-E Remedial Action Work Plan (RAW) (Arcadis 2016a) and is shown in Figure 2-36.

BHHERA results indicated that baseline terrestrial excess lifetime cancer risks (ELCRs) range from less than one in a million (1×10^{-6}) to 4×10^{-5}, depending on the exposure scenario evaluated, with the highest risk for the commercial worker. Baseline terrestrial Hazard Indices (HIs) ranged from less than one to five, depending on the exposure scenario evaluated, with the highest HI for the construction worker. Dioxin TEQ concentrations in soil in the terrestrial OU-E lowland AOI represented the largest contributor to potential cancer risk and non-cancer hazard (Arcadis, 2015b). The ELCRs and HIs presented in the BHHERA assumed the identified hot spots remained in place. The hot spots were removed in accordance with the OU-E Removal Action Work Plan (RAW; see Section 2.2.7) and, therefore, actual residual ELCRs and HIs are lower than presented in the BHHERA.

Results of the ERA for the terrestrial exposure area indicated that potential unacceptable risk for populations of plants, soil invertebrates, birds, and mammals is unlikely. Hazard Quotients (HQs) were generally less than one, or COPC EPCs were below site-specific background concentrations. Barium HQs for plants, invertebrates, and invertivorous mammals were greater than one, but were driven by a few samples located in a small area of the site, indicating potential population-level exposure is limited. Furthermore, the ERA concluded that exposure of individual receptors in the small area would not result in unacceptable effects to local populations.

2.2.6.2 Aquatic AOI Risk Assessment

For the Aquatic AOIs, the BHHERA evaluated all 10 aquatic AOIs. Ponds 1, 2, 3, and 4 were combined into a single Southern Ponds AOC, resulting in a total of seven aquatic AOIs as separate exposure areas in the BHHERA (Ponds 1 through 4, Pond 5, Pond 6, Pond 7, the North Pond, Pond 8, and Pond 9). Additionally, all ponds were evaluated as one exposure area (the Combined Aquatic AOI) under two exposure scenarios: assuming 50 days exposure per year and 12 days of exposure per year. DTSC has indicated that they are primarily interested in the results of the risk assessment for the individual aquatic AOIs using the 50-day exposure frequency (DTSC, 2016). Within the Aquatic AOI, the following hot spots were identified for the following constituents in the vicinity of the indicated locations:

- Dioxin TEQ and arsenic (Figures 2-23, 2-24, and 2-25):
    - Pond 3 RAA: two sample locations (Pond 3-01 from 0.5 to 1.5 feet bgs and DP-7.13 from 0 to 0.5 feet bgs)
    - Pond 2 RAA: one sample location (Pond 2-02 from 0 to 1 feet bgs)
    - Pond 7 RAA: five sample locations (DP-4.11 from 6 to 6.5 feet bgs, Pond 7-01 from 0 to 0.5 feet bgs and 0.5 to 1.5 feet bgs, DP-4.12 from 6 to 6.5 feet bgs, Pond 7-02 from 0 to 3.5 feet bgs, and DP-4.13 from 0 to 0.5 feet bgs).
- Dioxin TEQ (only) (Figure 2-26):
    - Riparian-1 RAA: one sample location (OUD-HA-044 from 0 to 0.5 feet bgs)

- Riparian-2 RAA: one sample location (OUD-HA-046 from 0 to 0.5 feet bgs)
- Riparian-3 RAA: one sample location (OUD-SED-HA-049 from 0 to 0.5 feet bgs)
- Riparian-4 RAA: one sample location (OUD-HA-042 from 0 to 0.5 feet bgs).

For the Combined Aquatic AOI (i.e., all 10 aquatic AOIs combined), ELCRs and HIs for the occasional (passive) recreator were below 1×10^{-6} and 1, respectively, when a 12 day per year exposure frequency was considered. Using the 50-day exposure frequency, the HIs for the occasional (passive) recreator remained below 1 for potential noncancer effects, while the ELCRs were 5×10^{-6} (0 to 0.5 foot bgs interval) and 6×10^{-6} (0 to 2 feet bgs interval). For both sediment intervals, arsenic and dioxin TEQ were the primary risk drivers via incidental sediment ingestion.

The separate aquatic AOIs were evaluated using the conservative exposure frequency of 50 days per year. Since a lower exposure frequency would be expected in Ponds 1 through 4 due to proposed “industrial” and “urban reserve” land uses (Section 2.1.1), the BHHERA also evaluated the Southern Ponds AOC assuming potential exposures of 12 days per year.

The separate aquatic AOI evaluations indicated HIs for all ponds were 1 or less, assuming an exposure frequency of 50 days per year. ELCRs for Ponds 5 and 9 were below 1×10^{-6}. Aquatic ELCRs for the passive recreational visitor, as analyzed on an individual pond basis, ranged from less than 1×10^{-6} (Ponds 5 and 9) to 2×10^{-5} (Pond 7).

The ERA for the aquatic AOIs concluded that unacceptable risks are not expected for populations of plants, benthic organisms, amphibians, birds, or mammals exposed to COPC in sediment. However, there is potential for localized risk to benthic organisms from barium exposure in Pond 7 sediment, based on comparison of porewater barium concentrations to the selected surface water screening level (Regional Water Quality Control Board [RWQCB], 2013).

The BHHERA results for the seven aquatic AOIs are summarized below:

- <u>Ponds 1 through 4 (Southern Ponds) AOI</u> – HIs were below one. ELCRs for the 50 days per year scenario in the 0 to 0.5 foot bgs and 0 to 2 feet bgs exposure intervals were 8×10^{-6} and 7×10^{-6}, respectively. ELCRs for the 12 days per year scenario in the 0 to 0.5 foot bgs and 0 to 2 feet bgs exposure intervals were both $2 \times 10^{-6.}$ For both exposure scenarios, the potential exposure to arsenic and dioxin TEQ from sediment ingestion was the primary contributor to the ELCRs. Two RAAs were identified within the Southern Ponds AOC (in Ponds 2 and 3) in the OU-E RAW, as discussed above. The associated hot spots were removed in 2017. The ELCRs and HIs presented in the BHHERA assumed the identified hot spots remained in place and, therefore, actual residual ELCRs and HIs are lower than presented in the BHHERA.

- <u>Pond 5 AOI</u> – The occasional recreator HI and ELCR for Pond 5 were below 1 and 1×10^{-6} respectively, using the 50-days-per-year exposure frequency. Because the ELCR for Pond 5 was below the risk management threshold of 1×10^{-6}, Pond 5 will be recommended for no further action in the OU-E Remedial Action Plan (RAP) and is, therefore, not discussed further herein.

- Pond 6 AOI – Pond 6 ELCRs were 4 x 10^{-6} and 3 x 10^{-6}, for the 0 to 0.5 foot bgs exposure interval and the 0 to 2 feet bgs interval using the 50-days-per-year exposure frequency, respectively. For both sediment intervals, arsenic and dioxin TEQ were the primary risk drivers via incidental sediment ingestion.

- Pond 7 AOC – Pond 7 ELCRs were 2 x 10^{-5} in both the 0 to 0.5 foot bgs and 0 to 2 feet bgs depth intervals under the 50 days-per-year exposure frequency. For both sediment intervals, arsenic and dioxin TEQ were the primary risk drivers via incidental sediment ingestion. Pond 7 AOC contained the highest sediment concentrations of dioxin TEQ of all the ponds on site (1,227 pg/g at 0 to 0.5 feet bgs and 1,668 pg/g at 0 to 2 feet bgs). Pond 7 AOC contained arsenic greater than local background concentrations (11 to 103 mg/kg at 0 to 0.5 feet bgs, and 11 to 115 mg/kg at 0 to 2 feet bgs). Sediment was removed from Pond 7 in 2017 (Kennedy/Jenks 2018). The ELCRs and HIs presented in the BHHERA assumed the identified hot spots remained in place and, therefore, actual residual ELCRs and HIs are lower than presented in the BHHERA.

- Pond 8 AOC – Pond 8 ELCRs were 2 x 10^{-6} in both the 0 to 0.5 foot bgs and 0 to 2 feet bgs depth intervals using the 50-days-per-year exposure frequency. For both sediment intervals, arsenic and dioxin TEQ were the primary risk drivers via incidental sediment ingestion, but this result is conservative. The results presented in the BHHRA for Pond 8 are mitigated by the following factors:

    - From a practical standpoint, exposure to the sediments in Pond 8 for any duration is remote due to site-specific factors that discourage access such as dense vegetation, steep banks, and cold surface water and air temperatures for much of the year. Potential future restrictions on boating, swimming, wading, fishing, and other active recreation in Pond 8 for the protection of public safety from physical hazards such as drowning and entrapment in deep, soft sediment and the protection of wildlife are also consistent with a more limited estimate of exposure.
    - From a risk analysis standpoint, arsenic concentrations in Pond 8 are comparable to background, so arsenic ELCRs are not associated with site conditions for the Pond 8 AOC. When the Pond 8 occasional recreator is evaluated without considering background arsenic exposures, the resulting cumulative ELCR in Pond 8 is 1 x 10^{-6}.
    - The range of concentrations of COCs in Pond 8 are generally similar in magnitude throughout the pond, but decrease within that range to the west, where water is shallowest. Concentrations increase toward the east where the discharges from Alder and Maple creek enter the pond and water is deepest.

- Pond 9 AOI – The occasional recreator HI and ELCR for Pond 9 were below 1 and 1 x 10^{-6} respectively, using the 50-days-per-year exposure frequency. Because the ELCR for Pond 9 was below the risk management threshold of 1 x 10^{-6}, Pond 9 will be recommended for no further action in the OU-E RAP and is therefore not discussed further herein.

- North Pond AOI – ELCRs were 2 x 10^{-6} in both the 0 to 0.5 foot bgs and 0 to 2 feet bgs depth intervals using the 50-days-per-year exposure frequency. Arsenic was the primary risk contributor in North Pond. Arsenic was detected at concentrations greater than background (10 mg/kg) in one sediment sample, at a concentration of 32.7 mg/kg.

Cancer and noncancer risks were evaluated for occasional recreators in the combined aquatic exposure area. As noted above, actual recreational exposures to pond sediments and surface water are unlikely. ELCRs and HIs for the occasional recreator in aquatic areas were below target thresholds for potential cancer and noncancer effects when a 12-day exposure frequency was considered. When a conservative alternative exposure frequency (50 days per year) was assumed, the HIs were below one, and the ELCRs in the 0 to 0.5 foot bgs and 0 to 2 feet bgs exposure intervals remained low (5×10^{-6} and 6×10^{-6}, respectively). Dioxin sediment ingestion exposures made up the greatest proportion of the ELCR for this alternative recreator scenario (54% for the 0 to 0.5 foot bgs interval and 63% for the 0 to 2 feet bgs interval). Within the combined aquatic exposure area, the highest concentrations of dioxin TEQ were detected in sediments collected from Pond 7 (samples Pond 7-01 and Pond 7-02). An exposure frequency of 50 days per year is a conservative assumption.

Results of the ERA for combined aquatic exposure areas indicated that unacceptable risk is not likely for populations of plants, benthic organisms, birds, mammals and amphibians exposed to site sediment and surface water. ERA results for ponds evaluated individually indicated potential risk is not likely, with the exception of barium partitioning to porewater in Pond 7 sediment, which may pose a potential risk to benthic organisms based on comparison of porewater concentrations at locations Pond 7-01 (1,570 micrograms per liter [μg/L]), Pond 7-01 (1,935 μg/L), and DP-4.13 (1,780 μg/L) to the selected screening level of 1,000 μg/L.

2.2.6.3 Riparian AOI Risk Assessment

Riparian Area AOI soil and groundwater were evaluated for human health risks in the BHHRA section of the DTSC approved OU-C and OU-D RI as part of the Open Space exposure unit (EU). The Open Space EU includes the Log Storage and Sediment Stockpile AOI, the Riparian AOI, and the "Open Space" designated areas of the West of IRM AOI and IRM AOIs. ELCRs and HIs for all receptors (resident, commercial/industrial, construction, and utility/trench workers, and both recreational visitors) evaluated in the Open Space EU were below DTSC's thresholds.

The DTSC approved OU-C and OU-D RI additionally states, "Sediment data are available for the riparian subarea of the Open Space EU. This area will be designated as open space, and access to this sensitive resource area will be limited. As a result, exposure by a hypothetical human receptor (recreator) to constituents in sediment is assumed to be insignificant, and sediment data were not evaluated as part of the Open Space EU BHHRA."

The Riparian AOI was evaluated for ecological risks in the DTSC approved OU-C and OU-D RI as part of the open space exposure unit. The OU-C and OU-D baseline ecological risk assessment (BERA) for the open space exposure unit included upper and lower trophic level receptors. In the riparian area, BERA HQs were less than one for all avian and mammalian receptors. The OU-C and OU-D RI (Arcadis, 2011a) identified metals, PAHs and dioxins/furans exceeding conservative sediment screening levels for protection of benthic organisms in the Riparian AOI. In order to further evaluate the risks posed by metal and PAH concentrations, porewater and sediment data were collected under the OU-E BHHERA investigation.

Based on the outcomes of the metals and PAH evaluations, the BHHERA concluded that ecological risk in the OU-D Riparian AOI is negligible. No further evaluation for dioxin/furan risk was performed in the BHHERA because invertebrates lack specific biochemical receptors essential to produce dioxin related toxicity (Céspedes et al., 2010; Hahn, 2002; West et al., 1997). Dioxin toxicity is expressed via the aryl hydrocarbon receptor in vertebrates. However, invertebrates lack the aryl hydrocarbon receptor, and aryl hydrocarbon receptor homologues identified in invertebrates have been shown to not bind dioxin compounds (Céspedes et al., 2010; Hahn, 2002; West et al., 1997). Furthermore, toxicity testing conducted on various invertebrate species has shown no toxicity associated with tissue concentrations up to 9.5 mg/kg lipid (West et al., 1997).

2.2.7 OU-E Removal Action Work Plan

The OU-E RAW was developed to expedite remediation of certain AOIs/AOCs to facilitate construction of the City of Fort Bragg's coastal trail and expedite remediation of the site. The AOIs/AOCs included in the OU-E RAW are the Lowland Terrestrial AOI, the Ponds 1, 2, 3, and 4 (Southern Ponds) AOC, the Riparian AOI, and the Pond 7 AOC. The OU-E RAW included an evaluation of remedial alternatives and proposed excavation and disposal as the selected remedial action. The OU-E RAW and, therefore, the excavation and disposal remedial alternative, was approved by DTSC on 13 October 2016 (DTSC, 2016b). A summary of completed activities is presented in the Remedial Action Completion Report (RACR; Kennedy/Jenks 2018). The Lowland Terrestrial Soil AOI and its four associated AOIs (discussed further in Section 2.3.1 and Section 4.1.1) and the Riparian AOI (discussed further in Section 2.3.2.5 and Section 4.1.4) were recommended for No Further Action (NFA) in the RACR and approved by DTSC (DTSC 2018a).

2.3 Nature and Extent of Chemicals of Concern

A detailed analysis of soil, sediment, and groundwater conditions for AOIs within, and associated with, OU-E were provided in the OU-E RI Report (Arcadis, 2013a), the OU-C and OU-D RI Report (Arcadis, 2011a), and the BHHERA (Arcadis, 2015a). Only conditions identified in the OU-E RI Report and the OU-C and OU-D RI Report as needing further evaluation are addressed in this section. As discussed previously, the AOIs have been grouped into three sections depending on nature and extent of constituents. AOIs/AOCs discussed in this FS are as follows:

- Lowland Terrestrial AOI (includes the Water Treatment and Truck Dump AOI, Sawmill #1 AOI, Compressor House and Lath Building AOI, and Powerhouse and Fuel Barn AOI)
- Aquatic AOCs
  - Ponds 1, 2, 3, and 4 (Southern Ponds) AOC
  - Pond 6 and North Pond AOC
  - Pond 7 AOC
  - Pond 8 AOC
  - Riparian AOI
- Groundwater AOC (includes IRM AOI and West of IRM AOI).

As discussed in Section 2.2.4, the Pond 8 Fill Area AOI was recommended for no further action in the OU-E RI Report due to no sample exceedances of human health PSLs. In accordance with the OU-E RI Report, the Pond 8 Fill Area AOI was not included within the Lowland Terrestrial AOI dataset used for the BHHERA. The Pond 8 Fill Area AOI is, therefore, not considered in this FS. As discussed in Section 2.2.7, the Lowland Terrestrial Soil AOI and Riparian AOI were approved for NFA in the RACR.

Chemical concentrations in the AOCs are compared to PSLs in the following sections. PSLs were presented in the OU-E RI and are provided again in Appendix C.

2.3.1 Soil Conditions in Lowland Terrestrial Area of Interest

2.3.1.1 Water Treatment and Truck Dump AOI

Localized concentrations of metals above PSLs (antimony, arsenic, barium, chromium, copper, lead, mercury, molybdenum, and zinc) and PAHs were identified in the OU-E RI Report. B(a)P TEQ concentrations in two samples collected from this area (OUE-DP-099 at 0.5 to 1.0 foot bgs, and OUE-DP-100 at 2.5 to 3.5 feet bgs) (Figure 2-33) were identified as hot spots in the OU-E BHHERA and are within PRAs. The PRAs were proposed for removal in the OU-E RAW.

Further remedial action to address soil at the Water Treatment and Truck Dump AOI is discussed in Section 7.1.

2.3.1.2 Sawmill #1 AOI

Localized concentrations of metals (antimony, arsenic, barium, copper, chromium, lead, mercury, molybdenum, nickel, vanadium, and zinc) and TPHd were detected above PSLs in the Sawmill #1 AOI. The BHHERA identified hot spots for lead in soil in the vicinity of two sample locations (OUE-DP-070 from 3 to 4 feet bgs; and DP-05.57 from 0.5 to 1 foot bgs). These locations (Figure 2-35) were identified as PRAs for inclusion in this FS. The PRAs were proposed for removal in the OU-E RAW.

The OU-E RI Report identified a localized area under the east end of the former Sawmill #1 Building where TPHd and PAH were detected above PSLs (Figure 2-20). PAHs were also detected along the drain line south of the Former Sawmill #1 Building. The BHHERA identified four sample locations as hot spots within the Sawmill #1 AOI. The four sample locations (OUE-DP-073, OUE-DP-074, OUE-DP-075, and OUE-DP-026) range in depths from approximately 2 to 3.5 feet bgs and form a single PRA for evaluation in this FS (Figure 2-33). One location (OUE-DP-025, 12,634 mg/kg) slightly exceeds the human health screening level of 10,772 mg/kg and was not identified as a human health hot spot based on the limited risk relative to the human health PSL. The PRAs and the area around OUE-DP-025 were proposed for removal in the OU-E RAW.

Further remedial action to address soil at the Sawmill #1 AOI is discussed in Section 7.1.

2.3.1.3 Compressor House and Lath Building AOI

Historical and RI sampling data from the Compressor House and Lath Building AOI indicate no detections of metals, total petroleum hydrocarbons in the gasoline range (TPHg), TPHmo, TPHd, PCBs, or VOCs above human health screening levels. Localized PAHs were detected above PSLs within the extent of the former Compressor House excavation (Figure 2-20).

2.3.1.4 Powerhouse and Fuel Barn AOI

Historical and RI sampling data from the Powerhouse and Fuel Barn AOI indicate detections of metals (antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, vanadium, and zinc), dioxin, and PAHs above PSLs. The BHHERA identified hot spots for lead in the vicinity of two sample locations (OUE-DP-094 from 5.5 to 6 feet bgs; and OUE-DP-090 from 5.5 to 6 feet bgs). These two locations (Figure 2-35) were identified as PRAs for inclusion in this FS. The PRAs were proposed for removal in the OU-E RAW.

The maximum dioxin TEQ (2.729 pg/kg) was detected at OUE-DP-052 from 0.5 to 1.5 feet bgs within the extent of the former Open Refuse Fire Area (Figure 2-21). This location was identified as a dioxin TEQ hot spot in the BHHERA and is included as a PRA within this FS (Figure 2-34). This PRA was proposed for removal in the OU-E RAW.

The maximum B(a)P TEQ concentration detected in the Powerhouse and Fuel Barn AOI was 27 mg/kg at sample location HSA-4.3 from 2 to 2.5 feet bgs, at the northwest corner of the former fuel barn (Figure 2-20). This location was identified as a B(a)P TEQ hot spot in the BHHERA and is included as a PRA in this FS (Figure 2-33). This PRA was proposed for removal in the OU-E RAW.

Further remedial action to address soil at the Powerhouse and Fuel Barn AOI is discussed in Section 7.1.

2.3.1.5 Grouping for Further Analysis

For the remainder of this FS, the Water Treatment and Truck Dump AOI, Sawmill #1 AOI, and the Powerhouse and Fuel Barn AOI are grouped as a single AOI unit known collectively as the Lowland Terrestrial Soil AOI.

2.3.2 Sediment Conditions in Aquatic Areas of Concern

The nature and extent of COC concentrations in sediment in the aquatic AOCs are described in the following sections. Sediment COC concentrations will likely continue to decline naturally through existing biological and geochemical processes (ITRC 2014; USEPA 2005; USEPA 2014; ENVIRON 2009). Molecules of organic COCs degrade and transform into simpler and less toxic compounds via biological and geochemical processes. Metals such as arsenic and recalcitrant compounds such as PAHs transform from bioavailable species and accessible forms into less available forms through precipitation and combination with available minerals such as iron oxide complexes and sequestration by binding to organic carbon molecules, making them unavailable to potential receptors. These natural recovery processes are present and were documented in the BHHERA via arsenic speciation testing and carbon EqP modeling. Further, geomorphological and biological cycles in the ponds generate additional sediment mass through inputs from erosion and accumulation of organic material from biological growth and decay. Additions of new sediment minerals and organic carbon subsequently result in diffusion and dispersion of residual COC concentrations over time. These natural recovery processes are likely to provide the majority of COC concentration reductions in the aquatic AOCs. However, degradation may not occur within a reasonable timeframe and it is not feasible to monitor degradation in the sediment; therefore, monitored natural attenuation is not included as a remedial alternative for aquatic AOCs in Section 5.

2.3.2.1 Ponds 1 through 4 (Southern Ponds)

The following conditions are typical of the Southern Ponds, though water levels vary seasonally and Ponds 1, 2, and 4 are periodically dry during the summer.

- In Pond 1, the maximum water depth is typically 1 foot and sediment is approximately 3 feet thick. The surrounding land surface is approximately 5 feet above observed water.
- In Pond 2, the maximum water depth is typically 3 feet and sediment is approximately 6 feet thick. The surrounding land surface is approximately 5 feet above observed water.
- In Pond 3, the maximum water depth is typically 4 feet and sediment is approximately 6 feet thick. The surrounding land surface is approximately 5 feet above observed water.
- In Pond 4, the maximum water depth is typically 4 feet. Sediment was not observed in Pond 4. The surrounding land surface is approximately 5 feet above observed water.

Dioxin and metals (arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, and zinc) were detected at concentrations above PSLs in Ponds 1, 2, and 3 during historic and RI sampling activities (Figure 2-25). Historical and RI sediment sample results for Ponds 1, 2 and 3 indicated no detections of TPHg, TPHmo, and PCBs above PSLs. Hot spot excavation for arsenic and dioxin TEQ was completed in Pond 2 and Pond 3 in 2017. Based on sample results for soil not excavated, approximately 72% of samples collected from the Southern Ponds exceed unrestricted cleanup goals and, therefore, it is estimated that approximately 7,000 CY of sediment containing COCs above unrestricted cleanup goals remains in the Southern Ponds. Prior to hot spot removal the EPCs in the 0 – 2-foot bss range and maximum concentrations overall of COCs were 45.8 mg/kg and 98.9 mg/kg for arsenic and 442 pg/g and 1,285 pg/g for dioxin. The maximum remaining concentrations of arsenic and dioxin TEQ following hot spot removal are 70 mg/kg and 473 pg/g respectively. A statistical summary of detections was presented in the OU-E RI and is provided herein as Appendix B.

As discussed in Section 2.2.6.2, the Southern Ponds were evaluated as a combined aquatic AOC in the BHHERA, using both a 12-days-per-year and 50-days-per-year exposure scenario. The ELCRs for both exposure frequencies were within the range of 2×10^{-6} to 8×10^{-6}. Potential exposure to arsenic and dioxin TEQ via sediment ingestion was the primary contributor to human health risk. Remediation was completed in the Southern Ponds in accordance with the OU-E RAW in 2017 (Kennedy/Jenks, 2018) to make site conditions suitable for planned future uses, including an ecological restoration project. Implementation and confirmation sampling results are presented in the Remedial Action Completion Report for Operable Units OU-C, OU-D, and OU-E (RACR; Kennedy/Jenks 2018). LUCs are likely to be required for sediment that remains in the Southern Ponds and will include mechanisms for future activities in the Southern Ponds, including ecological restoration and maintenance activities.

2.3.2.2 North Pond and Pond 6

In the North Pond, the maximum water depth is typically 1.5 feet and sediment is approximately 8.5 feet thick. In Pond 6, the maximum water depth is typically 2 feet and sediment is approximately 10 feet thick. The surrounding land surface is approximately 3 feet above the observed water.

Historical and RI soil sample results from the North Pond and Pond 6 indicated concentrations of TPHg, TPHmo, and PCBs in sediment were below PSLs. Sediment samples from Pond 6 contained concentrations of metals (arsenic and lead), PAHs, and dioxins/furans above PSLs. PAHs detected above PSLs in Pond 6 were limited to shallow sediments. PAHs and arsenic were detected at concentrations above PSLs in the North Pond. PAHs were present in the North Pond in deeper soil from 19.0 to 19.5 feet bss. (Figures 2-22 and 2-23). Arsenic and dioxin TEQ were the primary risk drivers within Pond 6 sediment, while arsenic was the primary risk contributor in the North Pond. At Pond 6 the EPCs in the 0 – 2-foot bss range and maximum overall concentrations of COCs were 28.2 mg/kg and 37.2 mg/kg, respectively, for arsenic and 175 pg/g (EPC equal to maximum for Pond 6) for dioxin TEQ. At the North Pond, the EPC and maximum concentration of arsenic is 32.7 mg/kg (EPC equal to maximum in North Pond). A statistical summary of detections was presented in the OU-E RI and is provided herein as Appendix B. Approximately 50% of samples collected from the North Pond and Pond 6 exceed unrestricted cleanup goals and, therefore, it is estimated that approximately 1,000 CY of sediment containing COCs above unrestricted cleanup goals remains in the North Pond and Pond 6.

As discussed in Section 2.2.6.2, Pond 6 and the North Pond were evaluated as two individual aquatic AOIs in the BHHERA, assuming an exposure of 50 days per year. The ELCRs for both ponds were within the range of 2×10^{-6} to 4×10^{-6}.

2.3.2.3 Pond 7

Prior to recent sediment removal in Pond 7, the water depth was typically 6 feet and sediment was approximately 7 feet thick. The maximum concentration of dioxin TEQ in Pond 7 in the 0 – 2 feet bss range was 1,688 pg/g and the maximum concentration of dioxin TEQ in the 0 – 0.5 feet bss range was 1,227 pg/g prior to recent sediment removal, and these maximum values were used as EPCs in the BHHERA based on the ProUCL outputs. ProUCL uses the maximum concentration when a 95% UCL cannot be calculated because of the data distribution. Currently, water is approximately 10 feet deep, and approximately 3 feet of fill was placed in Pond 7 following excavation activities. The surrounding land surface is approximately 2 feet above the observed water. Historical and RI sediment samples from Pond 7 contained concentrations of metals (arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, and zinc), PAHs and dioxins/furans above PSLs (Figures 2-22 and 2-23). Hot spot excavation was completed in 2017 to remove all accessible sediment (Kennedy/Jenks, 2018). Residual concentrations in 5 confirmation samples collected from the side of the Mill Pond Dam along the south wall indicate dioxin TEQ concentrations (between 93 and 350 pg/g) above the unrestricted use goal but below the not-to-exceed goals established in the RAW.

Based on confirmation samples collected after the hot spot excavation, it is estimated that approximately 900 cy of sediment containing COCs above unrestricted cleanup goals remains along the southern perimeter of Pond 7 with a maximum concentration of 350 pg/g. New 95%

UCLs have not been calculated for the remaining sediment but may be near or equal to the maximum as indicated by ProUCL for the original data set. 350 pg/g is below the NTE value selected in the OU-E RAW as protective of the 12-day recreator for sediment. A statistical summary of previous detections was presented in the OU-E RI and is provided herein as Appendix B. As discussed in Section 2.2.6.2, Pond 7 was evaluated as an individual aquatic AOI in the BHHERA, assuming an exposure of 50 days per year. The ELCR for Pond 7 was 2 x 10^{-5}. Potential exposure to arsenic and dioxin TEQ via sediment ingestion was the primary contributor to human health risk. Arsenic and dioxin TEQ were the primary risk drivers within Pond 7 sediment. The ERA identified barium in Pond 7 sediment and porewater as a potential risk to benthic organisms based on comparison to the surface water screening level. Remediation was completed in Pond 7 in accordance with the OU-E RAW in 2017 to make site conditions suitable for planned future uses. Implementation and confirmation sampling results are presented in the RACR.

2.3.2.4 Pond 8

In Pond 8, the water depth is typically less than 1 foot in the west and up to approximately 5 feet in the east. Sediments range from approximately 6 feet to 24 feet thick. The top of the dam and surrounding land surface is approximately 10 feet above the observed water surface. Metals (arsenic, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, and zinc), PAHs, VOCs, dioxins/furans, PCBs, TPH and pesticides were detected in Pond 8 sediment at concentrations greater than PSLs. Sample locations where concentrations of COCs are above unrestricted remedial goals are found laterally throughout Pond 8 in both shallow and deeper sediment. (Figures 2-11 through15 2-16) The estimated quantity of sediment containing COCs above unrestricted cleanup goals is 106,000 cy. Generally, concentrations of COCs decrease to the west and are highest to the east. The maximum concentration of dioxin TEQ in Pond 8 is 243 pg/g and the EPC in the 0 – 2 feet bss range is 110 pg/g. A statistical summary of detections was presented in the OU-E RI and is provided herein as Appendix B.

As discussed in Section 2.2.6.2, Pond 8 was evaluated as an individual aquatic AOI in the BHHERA, assuming an exposure of 50 days per year. The ELCR for Pond 8 is 2 x 10^{-6}. Potential exposure to arsenic and dioxin TEQ via sediment ingestion was the primary contributor to human health risk. The arsenic concentrations within Pond 8, however, were comparable to background and the BHHERA concluded that arsenic concentrations were not related to site activities at Pond 8. When the ELCR was evaluated without the background arsenic exposure, the resulting cumulative ELCR in Pond 8 is 1 x 10^{-6}.

2.3.2.5 Riparian AOI

The OU-C and OU-D RI (Arcadis, 2011a) identified metals, PAHs and dioxins/furans at concentrations above PSLs in the Riparian AOI. Based on the results of the human health and ecological risk assessment presented in the OU-C and OU-D RI, including the conclusion that potential human exposure to sediment in the Riparian AOI is expected to be limited, the OU-C and OU-D RI recommended that Riparian AOI drainage area sediments should be carried forward into the FS due to potential ecological risk to benthic invertebrates (Arcadis, 2011a).

As discussed in Section 2.2.6.3, additional porewater and sediment data were collected in the Riparian AOI under the OU-E BHHERA investigation to further evaluate the risks posed by metal and PAH concentrations. Based on the BHHERA evaluation, the risks posed by metals and PAHs in Riparian AOI sediment were determined to be negligible. No further evaluation for dioxin/furan risk was performed in the BHHERA due to an incomplete exposure pathway for invertebrates (see Section 2.2.6.3). Remediation was completed in the Riparian Area in accordance with the OU-E RAW in 2017 to achieve site conditions suitable for planned future uses. Results of remediation activities and confirmation samples are presented in the RACR.

2.3.3 Groundwater Areas of Concern

Human health and ecological risks in the IRM and West of IRM AOIs were evaluated in the OU-C and OU-D RI (Arcadis, 2011a) and further assessment was, therefore, not conducted for the OU-E BHHERA (see Section 2.2.5). Historical and RI investigations at both the IRM and West of IRM indicated impacts to soil and groundwater, although IRMs discussed in Section 2.2.3.4 resulted in soil conditions that do not pose a risk to human health or the environment. The OU-C and OU-D RI recommended that IRM AOI and West of IRM AOI groundwater should be carried forward into the FS for fuel-related constituents (Arcadis, 2011a). No risks from groundwater were identified in the OU-E BHHERA. However, OU-E Lowlands AOI groundwater is also included in the FS due to barium detected in MW-4.1. Hydrographs for OU-E monitoring wells are provided in Appendix D.

2.3.3.1 IRM AOI

TPH-impacted soil was largely removed during the interim action excavation work. Slightly elevated TPHd concentrations remain in soil beneath the excavation area northwest of the MES, as shown in excavation confirmation samples. TPHd was analyzed and reported according to carbon chain fractions in this area. The maximum remaining concentrations are 420 mg/kg as C10 - C12, 3,200 mg/kg as C12 - C16, and 3,200 mg/kg as C16 - C24. These are below the human health screening value for direct contact and are not resulting in concentrations of TPHd in groundwater significantly above the WQO of 0.1 milligrams per liter (mg/L). These represent areas that could not be accessed during the interim action. Due to the excavation and remediation (biosparging and ORM application) work that was conducted in this AOI, at the time of the OU-C and D RI Report the existing groundwater data were considered not representative of current conditions downgradient of the Former Parcel 5 MES. Historical data indicated groundwater in the area upgradient (east) and south of the MES area was not impacted by site activities. Groundwater quality improvements for this AOI associated with the interim action was recommended for further assessment using data from groundwater monitoring wells MW-5.19 and MW-5.20. Concentrations of TPHd have declined at these two wells since monitoring began. As of the second semi-annual monitoring event 2017, concentrations of TPHd at MW-5.19 are near the WQO with concentrations below the WQO during two of the four events in the last 2 years. As of the second semi-annual monitoring event 2017, concentrations of TPHd at MW-5.20 are below the WQO for the second consecutive event. The maximum concentrations of TPHd at MW-5.19 and MW-5.20 in the last four events are 0.11 mg/L and 0.180 mg/L, respectively. The OU-C and D RI Report recommended the inclusion of the IRM AOI in the FS for fuel-related constituents in groundwater.

2.3.3.2 West of IRM AOI

Historical and RI sampling activities indicated TPHd concentrations in soil above screening levels in the area directly south of the excavation boundary and in the vicinity of the Former

Diesel AST and along the western edge of the excavation boundary as shown in excavation confirmation samples. TPHd was analyzed and reported according to carbon chain fractions in this area. The maximum remaining concentrations are 2,000 mg/kg as C10 - C12, 7,900 mg/kg as C12 - C16, and 6,500 mg/kg as C16 - C24, all at location DP-5.43 at a depth of 8.5 – 9 feet bgs. Concentrations in the same boring in the sampling intervals above and below this depth were less than 47 mg/kg for all fractions. These concentrations are below the human health direct contact screening level of 10,772 mg/kg and are not resulting in concentrations of TPHd in groundwater above the WQO of 0.1 mg/L. These are within areas that could not be accessed during the interim action. Due to the excavation and remediation (biosparging and ORM application) work that was conducted in this AOI, at the time of the OU-C and D RI Report the existing groundwater data were considered not representative of current conditions downgradient of the Former Parcel 5 MES. Groundwater quality improvements for this AOI associated with the interim action were to be further assessed using data from groundwater monitoring wells (MW-5.17, MW-5.18 and MW-5.21). Concentrations of TPHd have declined at these three wells since monitoring began and as of the second semi-annual monitoring event 2017, have been below the WQO for six or more consecutive events in the last three years. The maximum concentration of TPHd at MW-5.18 during the last four events is 0.041 mg/L[10], and TPHd was not detected above the reporting limit of approximately 0.05 mg/L at MW-5.17 and MW-5.21[11] during the last four events. The OU-C and D RI Report recommended the inclusion of the West of IRM AOI in the FS for fuel-related constituents in groundwater.

2.3.3.3 Grouping for Further Analysis

Based on post-IRM TPH groundwater concentrations, the OU-C and OU-D RI identified groundwater in the IRM and West of IRM AOIs for further evaluation in the FS. Additionally, barium is detected in MW-4.1 in the OU-E Lowlands at concentrations that historically have exceeded the Maximum Contaminant Level (MCL) and, therefore, groundwater in the OU-E Lowland AOI is also included in the FS. The concentration of barium at MW-4.1 was below the MCL in February 2017, the most recent event at MW-4.1 (Kennedy/Jenks 2017a). For the remainder of this FS, the IRM AOI, West of IRM AOI, and OU-E Lowlands AOI groundwater are grouped as a single AOC unit known collectively as the OU-E Groundwater AOC.

[10] This concentration was flagged as an estimated value by the laboratory.
[11] An estimated TPHd concentration was reported for MW-5.21 in one of the events below the typical reporting limit of 0.5 mg/L.

Section 3: Objectives and Requirements of Remediation

This section identifies and evaluates the objectives and requirements of remediation which will drive the development and screening of remedial alternatives.

3.1 Applicable or Relevant and Appropriate Requirements

CERCLA and its regulations (40 [Code of Federal Regulations] CFR 300 et seq., referred to as the NCP) provide an established, and generally accepted, framework for evaluating and remediating industrial sites. Under the NCP, remedial actions must attain (or justify the waiver of) any federal or more stringent state environmental standards and facility citing laws that are "applicable or relevant and appropriate." These regulatory requirements are known as ARARs. The ARARs are used to develop quantitative RAOs, determine the extent of site cleanup, and govern the implementation and operation of the selected alternatives.

Identification of ARARs must be completed on a site-specific basis and involves a two-part analysis: first, a determination of whether a given requirement is applicable and then, if it is not applicable, a determination of whether it is nevertheless both relevant and appropriate. Federal, state, and local ARARs can be divided into the following categories:

- <u>Chemical-specific ARARs</u>: Chemical-specific or ambient requirements include those laws and regulations that govern the release to the environment of materials possessing certain chemical or generally set health- or risk-based concentration limits, or discharge limitations for specific hazardous substances that may be found in, or discharged to, the ambient environment. If, in a specific situation, a chemical is subject to more than one discharge or exposure limit, the more stringent of the requirements should generally be applied.

- <u>Performance, design, or action-specific ARARs</u>: Action-specific ARARs consist of requirements that define acceptable handling, treatment, and disposal procedures for hazardous substances. These ARARs generally set performance, design, or other similar action-specific controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants. These requirements are triggered by the particular remedial activities that are selected to accomplish the cleanup remedy.

- <u>Location-specific ARARs</u>: Location-specific ARARs are those requirements that relate to the geographical or physical position of the site, rather than the nature of the contaminants or the proposed site remedial actions. These requirements may limit the type of remedial action that can be implemented and may impose additional constraints on the cleanup action.

A requirement may not meet the definition of an ARAR but may still be useful in determining whether to take action at a site or to what degree action is necessary. Some requirements are called to-be-considered (TBC) criteria. The TBC requirements are non-promulgated advisories or guidance issued by federal, state, or local government that are not legally binding, but may provide useful information or recommend procedures for remedial action.

ARARs and TBCs have been compiled for the soil, sediment, and groundwater in the AOCs addressed in this FS using federal, state, and local statues, regulations, and guidance listed in

Table 3-1. Note that the ultimate agency determination of requirements and conditions will be performed as part of the approval of permits requested for implementation of the selected alternative in response to a specific design or work plan.

3.2 Remedial Action Objectives

RAOs are medium-specific goals for protecting human health and the environment that, in consideration with the estimated remedial scope and cost for screening alternatives and existing data, will be used to define the scope of remediation work to be proposed in the forthcoming RAP. RBTLs will be calculated and presented in the RAP and will be used to evaluate site conditions. The RBTLs will be compared to post-remedy exposure estimates (i.e., 95% UCLs) to confirm that site conditions are protective of human and ecological receptors. GRAs are presented in Section 5.

RAOs are guidelines used in the development of potential remedial action alternatives and selection of a proposed remedial action. The RAOs presented herein have been developed based on the current environmental conditions and anticipated future use of the site.

- Prevent the ingestion of and incidental contact with chemicals of concern in soil that exceed Remedial Goals established in the RAP by future users of the former Mill Site. The relevant human exposure pathways for human receptors in the terrestrial exposure area include: incidental soil ingestion, dermal contact with soil, inhalation of particulates, and contact with groundwater (construction and utility workers only).
- Prevent the ingestion of and incidental contact with chemicals of concern in sediments that exceed Remedial Goals established in the RAP by future users of the former Mill Site. The relevant human exposure pathways for the passive recreator receptor in the aquatic area included: incidental sediment ingestion, dermal contact with sediment, and contact with surface water.
- For the AOC(s) with COC-impacted groundwater, provide a remediation alternative that will promote mitigation of COC-impacted groundwater to ultimately achieve North Coast RWQCB WQOs.

3.3 Chemical-Specific Remedial Goals

Chemical-specific remedial goals were presented in the OU-E RAW (termed “removal action goals”). The numeric goals are based on the DTSC memorandum *Identification of Presumptive Remedy Areas on Operable Unit E* (DTSC 2014) and an email dated 18 July 2014 and are site-specific. The following factors were considered in developing remedial alternatives:

- USEPA 2015 risk-based Regional Screening Levels (USEPA, 2015)
- Remedial Goals for Dioxins and Dioxin-like Compounds for Consideration at California Hazardous Waste Sites (DTSC, 2009)
- California Hazardous Waste threshold limiting concentrations (California Code of Regulations, Title 22. Social Security, Division 4.5. Health Standards for the Management of Hazardous Waste, Chapter 11. Identification and Listing of Hazardous Waste)

- Action levels for PCBs (under the performance-based approach) from the Toxic Substances Control Act of 1976 (40 CFR 761.3)
- North Coast Regional Water Quality Control Board WQOs (North Coast Regional Water Quality Control Board, 2011)
- Levels protective of human health, as presented in the DTSC Human and Ecological Risk Office (HERO) Human Health Risk Assessment Note Number 3 Modified Human Health Screening Levels (DTSC/HERO August 2017)
- Levels protective of ecological receptors, calculated using the literature-based ecological soil screening level bioaccumulation factor (USEPA 2007)
- Results presented in the Baseline Human Health and Ecological Risk Assessment (BHHERA; Arcadis, 2015a)
- Site-specific Remedial Goals developed for TPH, as presented in Appendix C of the OU-C/D RAP (Arcadis, 2015)
- Site-specific risk-based levels to be developed and proposed in the forthcoming RAP.

These factors are applied to site data to evaluate remedial strategies and focus activities to achieve remedial objectives. Active remediation to achieve these goals is not always technically feasible or economical. Recommended remedial alternatives may include natural attenuation, land use controls, and restricted use approaches to achieve conditions that meet remedial objectives.

Remedial objectives may be met through data collection, monitoring, and risk assessment that demonstrate that remedial action, attenuation, or risk management measures will achieve an acceptable level of risk. The BHHERA evaluation (discussed in Section 2.2.6) considered all OU-E aquatic AOIs as well as the OU-E terrestrial AOI (OU-E Lowland) prior to implementation of hot spot removal. When evaluated as individual aquatic AOIs, human health risks[12] for Southern Ponds, Pond 6, Pond 7, Pond 8, and North Pond were within the range of $2x10^{-5}$ to $2x10^{-6}$. Human health risks calculated in the BHHERA for Ponds 5 and 9 were below the risk management threshold (less than 1×10^{-6}) and, therefore, Ponds 5 and 9 are not included in this FS evaluation. The ERA indicated that unacceptable ecological risk is not likely for populations of plants, benthic organisms, birds, mammals and amphibians exposed to site sediment and surface water. The BHHERA evaluation concluded that terrestrial ELCRs are all below 1×10^{-6} when soil hot spots are removed from the terrestrial dataset. Hot spot excavation was completed in 2017. Consequently, risk in all evaluated areas of OU-E are expected to be within or below the range of 10^{-4} to 10^{-6}.

Draft media-specific, site-specific remedial goals are presented in Table 3-2. Chemical-specific remedial goals will be used to evaluate remedial action effectiveness following implementation and based on foreseeable future land use. Consistent with DTSC guidance for risk-based cleanups, chemical-specific remedial action goals will be applied based on a conservative estimate of the average concentration (e.g., 95% UCL on the mean) of a COC across an exposure area. This concentration is referred to as the EPC. For soil and sediment, the RBTLs and OU-E Removal Action Goals established in the OU-E BHHERA were used. As shown in Table 3-2, the remedial goals for groundwater at the site are based on Water Quality Objectives

[12] Evaluated in terms of ELCR.

(WQOs) set forth in the Water Quality Control Plan for the North Coast Region ("Basin Plan"; North Coast RWQCB, 2011, 2015). The background level of arsenic at this site is above the WQO for arsenic. Therefore, the background concentration for arsenic for the Former Georgia-Pacific Mill Site is the Remedial Goal for this COC (ARCADIS, 2010d).

Section 4: Areas and Volumes for Remedial Alternative Development

The area and vertical extent of soil and groundwater within OU-E to be incorporated into remedial alternative development is presented in this section. The delineation of remedial areas and volumes is based on the RAOs, the BEHHRA, available site analytical data, and site history. The areas exceeding remedial goals and estimates of contaminant mass are used as the basis for developing remedial alternatives and evaluating their ability to achieve the RAOs. Area and volume estimates are provided below by AOC.

4.1 Areas Addressed in OU-E RAW

The OU-E RAW evaluated risk, presented estimated areas and volumes for excavation, and evaluated the selected remedial action for select AOCs. These discussions are re-presented in the following sections.

4.1.1 Lowland Terrestrial Soil

4.1.1.1 Risk Summary

The RAW RAAs, as presented in the following sections, were developed considering the results of the hot spot analysis included in the BHHERA (Arcadis 2015a), to accelerate remediation within the identified AOCs by removing areas where elevated concentrations of COPCs have been identified, to reduce the risk to human health and the environment, and to support the construction and public use of the central portion of the Fort Bragg Coastal Trail. Remediation activities were completed at the RAW RAAs in accordance with the OU-E RAW in 2017 to reduce risks to public health and the environment. The BHHERA evaluation concluded that terrestrial ELCRs are all below 1×10^{-6} when soil hot spots are removed from the terrestrial dataset. Confirmation samples collected following hot spot removal met not-to-exceed goals established in the RAW to maintain residual risk below 1×10^{-6}. Results of remediation activities and confirmation samples are presented in the RACR.

4.1.1.2 Area Exceeding Remedial Goals

4.1.1.2.1 Water Treatment and Truck Dump Area of Interest

Based on the RI results, the BHHERA (Arcadis 2015a) identified two hot spots within this AOI based on B(a)P TEQ concentrations (OUE-DP-099 at 0.5 to 1.0 foot bgs and OUE-DP-100 at 2.5 to 3.5 feet bgs).

4.1.1.2.2 Sawmill #1 Area of Interest

Based on the RI results, the BHHERA (Arcadis 2015a) identified hot spots for lead in soil near two sample locations (OUE-DP-070 from 3 to 4 feet bgs and DP-05.57 from 0.5 to 1 foot bgs). The BHHERA identified four hot spots based on B(a)P TEQ concentrations in soil within the Sawmill #1 AOI. The four sample locations (OUE-DP-073, OUE-DP-074, OUE-DP-075, and

OUE-DP-026) range in depths from approximately 2 to 3.5 feet bgs. Based on communication with DTSC (DTSC 2016a) and the results of the RI Report (Arcadis 2013a), OUE-DP-025 was also identified as a RAA for TPHd.

4.1.1.2.3 Powerhouse and Fuel Barn Area of Interest

The BHHERA (Arcadis 2015a) identified hot spots for lead near two sample locations (OUE-DP-094 from 5.5 to 6 feet bgs and OUE-DP-090 from 5.5 to 6 feet bgs). The BHHERA also identified a hot spot for dioxin TEQ (2.729 picograms per kilogram) at OUE-DP-052 from 0.5 to 1.5 feet bgs within the former Open Refuse Fire Area. The maximum B(a)P TEQ concentration detected in the Powerhouse and Fuel Barn AOI was 27 mg/kg at sample location HSA-4.3 from 2 to 2.5 feet bgs, at the northwestern corner of the former fuel barn. This location was identified as a B(a)P TEQ hot spot in the BHHERA.

4.1.1.3 Area for Remedial Alternative Development

Each of the 12 hot spots identified in the OU-E Lowland AOI in the BHERRA (Arcadis 2015a) are RAAs. Four sample locations (OU-E-HA-023B, OU-E-DP-088, OUE-DP-076, and P4-40) were identified with lead concentrations exceeding the not to exceed (NTE) value established in the BHHERA (320 mg/kg). These locations were not previously identified as hot spots, as they are outside the depth interval evaluated in the BHHERA (0 to 6 feet bgs). However, these locations are co-located in the area and were selected for removal based on their exceedance of NTE criteria. The area surrounding boring location OUE-DP-025 was additionally identified for removal based on TPHd concentrations exceeding the soil remedial goal established in the Remedial Action Plan Operable Units C and D (OU-C/D RAP; Arcadis 2015b) for the protection of human health (10,772 mg/kg). Based on proximity, these locations were grouped into 12 distinct RAAs.

The RAAs are listed below, by constituent:

- B(a)P TEQ
    - RAA-B1 (Powerhouse and Fuel Barn AOI): includes one sample location (HSA-4.3 from 2 to 2.5 feet bgs)
    - RAA-B2 (Sawmill #1 AOI): includes four sample locations (OUE-DP-073 from 2 to 3 feet bgs, OUE-DP-074 at 2 to 3 feet bgs, OUE-DP-075 from 2 to 3 feet bgs, and OUE-DP-026 from 2 to 3.5 feet bgs)
    - RAA-B3 (Waste Treatment and Truck Dump AOI): includes two sample locations (OUE-DP-099 from 0.5 to 1.0 foot bgs and OUE-DP-100 from 2.5 to 3.5 feet bgs)
- Lead
    - RAA-L1 (Sawmill #1 AOI): includes one sample location (OUE-DP-070 from 3 to 4 feet bgs)
    - RAA-L2 (Sawmill #1 AOI): includes one sample location (DP-05.57 from 0.5 to 1 foot bgs)

- RAA-L3 (Powerhouse and Fuel Barn AOI): includes one sample location (OUE-DP-094 from 5.5 to 6 feet bgs)
- RAA-L4 (Powerhouse and Fuel Barn AOI): includes one sample location (OUE-DP-090 from 5.5 to 6 feet bgs)
- RAA-L5 (Powerhouse and Fuel Barn AOI): includes one sample location (OUE-DP-088 from 6 to 7 feet bgs)
- RAA-L6 (Powerhouse and Fuel Barn AOI): includes two sample locations (OUE-HA-023B from 6.5 to 8 feet bgs and OUE-DP-076 from 6 to 7 feet bgs and 8 to 9 feet bgs)
- RAA-L7 (Powerhouse and Fuel Barn AOI): includes one sample location: (P4-40 from 6.5 to 7 feet bgs)

- TPHd
  - RAA-T1 (Sawmill #1 AOI): includes one sample location (OUE-DP-025 from 1.5 to 5 feet bgs)

- Dioxin TEQ
  - RAA-D1 (Powerhouse and Fuel Barn AOI): includes one sample location (DP-052 from 0 to 0.5 foot bgs and 0.5 to 1.5 feet bgs)

Based on similarities in site conditions, evaluation and implementation of removal action alternatives for the 12 terrestrial RAAs were addressed in the OU-E RAW collectively as the OU-E Lowland RAA. As summarized in the BHHERA (Arcadis 2015a) and the RACR (Kennedy/Jenks 2018), removal activities in these RAAs reduced terrestrial EPCs of the B(a)P TEQ, lead, and dioxin TEQ to levels below the site-specific soil RBTLs developed by DTSC (DTSC 2014). Therefore, the RACR recommended the Lowland Terrestrial Soil AOI and the four associated AOIs for No Further Action (NFA) for soil. NFA was approved by DTSC (DTSC 2018a).

4.1.2 Ponds 1 through 4 (Southern Ponds) Aquatic Sediment

4.1.2.1 Risk Summary

Dioxins, arsenic, lead, and PAHs were detected in the Southern Ponds sediment at concentrations exceeding human health PSLs. Additional metals (barium, cadmium, chromium, cobalt, copper, mercury, molybdenum, nickel, and zinc) were detected above ecological PSLs. Risks were further evaluated in the BHHERA, and the BHHERA indicated ELCRs for the Southern Ponds were within the range of 2×10^{-6} to 8×10^{-6}, with arsenic and dioxin TEQ as the primary risk drivers. The ERA indicated that unacceptable ecological risk is not likely for populations of plants, benthic organisms, birds, mammals and amphibians exposed to site sediment and surface water. The Southern Ponds were further evaluated in the OU-E RAW (Arcadis 2016a).

4.1.2.2 Area Exceeding Remedial Goals

Potential ecological and human health aquatic risks were further evaluated in the BHHERA (Arcadis 2015a). For the human health evaluation of the Southern Ponds AOC, the BHHERA concluded that noncancer hazards are below 1, while cumulative excess lifetime cancer risks (ELCRs) for an occasional recreator (assuming 50 days per year of exposure) are greater than $1x10^{-6}$. Potential exposure to arsenic and dioxin TEQ from sediment ingestion are primary contributors to the ELCRs, with the COPC-specific ELCRs for arsenic and dioxin TEQ greater than $1x10^{-6}$. The ELCRs for the aquatic recreator receptors in the Southern Ponds AOC were within the range of 2×10^{-6} to 8×10^{-6}. The ERA concluded that unacceptable ecological risk is not likely for populations of plants, benthic organisms, birds, mammals, and amphibians exposed to sediment and surface water in the Southern Ponds AOC.

4.1.2.3 Area for Remedial Alternative Development

For aquatic AOCs, RAAs were developed based on risk drivers identified in the BHHERA (Arcadis 2015a). As indicated above, arsenic and dioxin TEQ are the primary risk drivers in the Southern Ponds AOC; therefore, the RAAs were defined to target locations with elevated concentrations of dioxins and arsenic. Removal activities in these portions of the Southern Ponds AOC were completed in 2017 to reduce arsenic and dioxin TEQ EPCs, thereby reducing potential risk. The RAAs within the Southern Ponds AOC were evaluated in the OU-E RAW collectively for removal alternative development as the Southern Ponds RAA. Results of remediation activities and confirmation samples are presented in the RACR. Based on sample results for soil not excavated, approximately 72% of samples collected from the Southern Ponds exceed unrestricted cleanup goals and, therefore, it is estimated that approximately 7,000 cy of sediment containing COCs above unrestricted cleanup goals remains in the Southern Ponds.

4.1.3 Pond 7 Aquatic Sediment

4.1.3.1 Risk Summary

Dioxins, arsenic, lead, and PAHs were detected in Pond 7 sediment at concentrations exceeding human health PSLs. Additional metals (cadmium, chromium, copper, mercury, molybdenum, nickel, and zinc concentrations) were detected above ecological PSLs. Risks were further evaluated in the BHHERA, and the BHHERA indicated the ELCR for Pond 7 was 2×10^{-5}. Arsenic and dioxin TEQ were the primary risk drivers in sediment. The ERA identified barium in Pond 7 sediment and porewater as a potential risk to benthic organisms based on comparison to the surface water screening level. Pond 7 was further evaluated in the OU-E RAW (Arcadis 2016a).

4.1.3.2 Area Exceeding Remedial Goals

Pond 7 was evaluated as an individual aquatic AOI in the BHHERA (Arcadis 2015a), assuming an exposure of 50 days per year. For the human health evaluation of the Pond 7 AOC, the BHHERA concluded that non-cancer hazards are below 1, while cumulative ELCRs for an occasional recreator (assuming 50 days per year of exposure) are 2×10^{-5}. Potential exposure to arsenic and dioxin TEQ from the sediment are primary contributors to the ELCRs. The ERA identified barium in Pond 7 sediment and porewater as a potential risk to benthic organisms based on comparison to the surface water screening level.

4.1.3.3 Area for Remedial Alternative Development

For aquatic AOCs, RAAs were developed based on risk drivers identified in the BHHERA (Arcadis 2015a). The entire footprint of Pond 7 was excavated in 2017. Residual concentrations in 5 confirmation samples collected from the side of the Mill Pond Dam along the south wall are above the unrestricted use goal but below the not-to-exceed sediment goals established in the RAW (between 93 and 350 pg/g). An area of approximately 5 feet wide and 180 feet long along the south perimeter of the pond where concentrations remain above unrestricted use goals is assumed as the new RAA for Pond 7. The RAA within the Pond 7 AOC is referred to as the Pond 7 RAA for removal alternative development. Results of remediation activities and confirmation samples are presented in the RACR.

4.1.4 Riparian Aquatic Sediment

4.1.4.1 Risk Summary

Dioxins, arsenic, zinc, PAHs, and TPH were detected in Riparian AOI sediment at concentrations exceeding human health screening levels. Additional metals were detected above conservative ecological screening levels. Arsenic concentrations were above the human screening level but generally comparable to background. TPH and PAHs concentrations were detected either below or just slightly exceeding the human health screening level. Riparian Area AOI soil and groundwater were evaluated for human health risks in the BHHRA section of the DTSC approved OU-C and OU-D RI as part of the Open Space exposure unit. The Open Space EU includes the Log Storage and Sediment Stockpile AOI, the Riparian AOI, and the "Open Space" designated areas of the West of IRM AOI and IRM AOIs. Exposure by a hypothetical human receptor (recreator) to constituents in sediment was accepted as insignificant, and ELCRs and HIs for all receptors (resident, commercial/industrial, construction, and utility/trench workers, and both recreational visitors) evaluated in the Open Space EU were below DTSC's thresholds. The OU-C and OU-D RI recommended that Riparian AOI drainage area sediments (dioxins/furans, metals, and PAHs) should be carried forward into the FS (Arcadis, 2011a) based on potential ecological risk to benthic organisms. Risks were further evaluated in the BHHERA, and the BHHERA indicated that the risks posed by metals and PAHs in Riparian AOI sediment were negligible. No further evaluation for dioxin/furan risk was performed in the BHHERA due to an incomplete exposure pathway for invertebrates (see Section 2.2.6.3). The Riparian Area was further evaluated in the OU-E RAW (Arcadis 2016a).

4.1.4.2 Area Exceeding Remedial Goals

Based on the results of the human health and ERA presented in the OU-C/D RI, the OU-C/D RI recommended that Riparian AOI drainage area sediments should be carried forward into the FS due to potential ecological risk to benthic invertebrates (Arcadis 2011a). The Riparian AOI was evaluated further in the OU-E RAW.

Risks were further evaluated in the BHHERA (Arcadis 2015a), which indicated that the risks posed by metals, dioxin/furans, and PAHs in Riparian AOI sediment were negligible. However, subsequent to the BHHERA, DTSC requested further evaluation for dioxin in the Riparian AOI (DTSC 2016a). Based on the relatively limited extent of concentrations above unrestricted use criteria in the Riparian AOI, RAAs within the Riparian AOI were evaluated in the OU-E RAW given the potential to meet unrestricted use and achieve No Further Action status in this area.

4.1.4.3 Area for Remedial Alternative Development

For the Riparian AOI, the RAAs were delineated based on samples OUD-HA-042, OUD-HA-044, OUD-HA-046, and OUD-SED-HA-049, which had dioxin TEQ concentrations that are higher than other sediment samples collected in the Riparian AOI. Removal activities in the Riparian AOI were completed in 2017 to reduce dioxin TEQ EPCs and thereby achieve a reduction in potential risk.

The RAAs within the Riparian AOI were evaluated in the OU-E RAW collectively for removal alternative development as the Riparian RAA. Implementation and confirmation sampling results are presented in the RACR. As described in the RACR, removal activities in the RAAs in the Riparian AOI reduced terrestrial EPCs of the dioxin TEQ to levels below the residential cleanup goal. Therefore, the RACR recommended the Riparian AOI for NFA. NFA was approved by DTSC (DTSC 2018a).

4.2 Areas Not Addressed in OU-E RAW

4.2.1 North Pond and Pond 6 Aquatic Sediment

4.2.1.1 Risk Summary

Dioxins, arsenic, and PAHs were detected in Pond 6 and North Pond sediment at concentrations exceeding human health PSLs. Lead was also detected above the human health PSL in Pond 6. Risks were further evaluated in the BHHERA, and the BHHERA indicated ELCRs for the North Pond and Pond 6 were within the range of 2 x 10^{-6} to 4 x 10^{-6}. Arsenic and dioxin TEQ were the primary risk drivers in Pond 6 sediment, while arsenic was the primary risk contributor in North Pond sediment. The ERA indicated that unacceptable ecological risk is not likely for populations of plants, benthic organisms, birds, mammals and amphibians exposed to site sediment and surface water.

4.2.1.2 Area Exceeding Remedial Goals

The North Pond and Pond 6 were evaluated as individual aquatic AOCs in the BHHERA (Arcadis 2015a), assuming an exposure of 50 days per year. For the human health evaluation of the North Pond and Pond 6 AOCs, the BHHERA concluded that non-cancer hazards are below 1, while cumulative ELCRs for an occasional recreator (assuming 50 days per year of exposure) are greater than 1×10^{-6}. Potential exposure to arsenic and dioxin TEQ from the sediment are primary contributors to the ELCRs. The majority of the risk in the North Pond and Pond 6 is attributed to arsenic. Dioxin-specific ELCRs for the two ponds do not exceed 1×10^{-6} and the maximum concentration of dioxin in the ponds is 175 pg/g. Maximum concentrations of arsenic in the North Pond and Pond 6 are 32.7 mg/kg and 30.2 mg/kg, respectively. COPC-specific risk values without considering the contribution of background arsenic would be lower for arsenic than calculated when using the EPCs for each pond, which are maximum concentrations due to the relatively limited data set. Based on the concentrations of arsenic and dioxin, the North Pond and Pond 6 exceed unrestricted use goals but do not contain significant hot spots where concentrations are isolated. While concentrations of arsenic in the ponds vary by location, generally arsenic is highest in sample depths less than 5 feet. The area exceeding remedial goals is assumed to be over the footprint of the ponds to depths between 2 and 5 feet.

4.2.1.3 Area for Remedial Alternative Development

Based on the areas affected by arsenic and dioxin, the areas for remedial alternative development in the North Pond and Pond 6 are approximately 3,000 and 7,000 sf, respectively. To a depth of approximately 5 feet this represents 1,800 cy.

4.2.2 Pond 8 Aquatic Sediment

4.2.2.1 Risk Summary

Dioxins, arsenic, lead, and PAHs were detected in Pond 8 sediment at concentrations exceeding human health PSLs. Risks were further evaluated in the BHHERA, and the BHHERA indicated the ELCR for Pond 8 is 2×10^{-6}. Arsenic and dioxin TEQ were the primary contributors to human health risk. The arsenic concentrations within Pond 8, however, were comparable to background, and the BHHERA concluded that arsenic concentrations were not related to site activities at Pond 8. When the ELCR was evaluated without the background arsenic exposure, the resulting cumulative ELCR in Pond 8 is 1×10^{-6}. The ERA indicated that unacceptable ecological risk is not likely for populations of plants, benthic organisms, birds, mammals and amphibians exposed to site sediment and surface water.

4.2.2.2 Area Exceeding Remedial Goals

Pond 8 was evaluated as an individual aquatic AOC in the BHHERA (Arcadis 2015a), assuming an exposure of 50 days per year. For the human health evaluation of the Pond 8 AOC, the BHHERA concluded that the non-cancer hazards are below 1, while cumulative ELCRs for an occasional recreator (assuming 50 days per year of exposure) are greater than 1×10^{-6}. Potential exposure to dioxin TEQ from the sediment is the primary contributor to the ELCR. The COPC-specific ELCR for dioxin TEQ is equal to 1×10^{-6}. Dioxin concentrations range between 0.000285 pg/g and 243 pg/g as 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) TEQ. The EPC within the 0 to 0.5 feet and 0 to 2 feet depth intervals used in the risk assessment are 118 pg/g and 110 pg/g, respectively. While the BHHERA indicated dioxin does not pose an unacceptable risk based on the expected future use for Pond 8, the pond does not meet the criteria for unrestricted use. The EPCs are above the California residential screening level of 50 pg/g and below the commercial/industrial screening level of 200 pg/g for the purpose of evaluating potential acceptable use.

While concentrations of dioxin in the pond are generally highest in the east near the storm drain outfalls and lowest in the west close to the ocean, significant variability is not observed laterally or vertically, particularly as compared to the screening levels, and no discernable patterns are observed. For example, concentrations are not the highest or lowest at the surface or in any given depth interval and may increase or decrease with depth depending on the location and may vary significantly in laterally or vertically adjacent samples. Based on this information the area exceeding the unrestricted use goal is defined as all Pond 8 sediment.

EPC for arsenic were calculated for Pond 8 and presented in the BHHERA. Arsenic EPCs ranged from 11.2 mg/kg (0 – 2 feet) to 12.3 mg/kg (0 – 0.5 feet), which exceed the background screening criteria for arsenic in soil (10 mg/kg). However, as presented in the Background Metals Report, background concentrations of arsenic in California soil range from 0.6 mg/kg to 31 mg/kg (Arcadis BBL 2007d).

4.2.2.3 Area for Remedial Alternative Development

Based on the area exceeding remedial goals and the relative uniformity of sediment quality, the area for remedial alternative development for Pond 8 is the 280,000 sf pond area. Sediment thickness ranges up to approximately 25 feet and is typically on the order of 10 feet on average. The total volume of sediment in Pond 8 is estimated to be 106,000 cy.

4.2.3 OU-E Groundwater

4.2.3.1 Risk Summary

The OU-C and OU-D RI recommended that IRM AOI and West of IRM AOI groundwater should be carried forward into the FS for fuel-related constituents (Arcadis, 2011a). Since the submittal of the OU-C/OU-D RI (Arcadis 2011a), both AOIs, as well as MW-4.1 in the OU-E Lowlands, have been assessed and continue to be monitored under the Comprehensive Monitoring Plan (CMP) and associated updates (Arcadis BBL 2007; Arcadis 2008a,b; Arcadis 2010b,c; Arcadis 2013c).

4.2.3.2 Area Exceeding Remedial Goals

Groundwater quality was most recently presented in the Second Semi-Annual 2017 Groundwater Monitoring Report (Kennedy/Jenks 2017b) for wells in Parcel 5 and the First Semi-Annual 2017 Groundwater Monitoring Report (Kennedy/Jenks 2017a) for MW-4.1. A summary of the most recent results reported is presented below:

TPHg was detected in MW-5.20 at an estimated concentration of 0.043 mg/L, which is less than the RWQCB taste and odor objective of 0.05 mg/L and the RBSC for aromatics and aliphatics of 0.31 mg/L (Kennedy/Jenks 2017b).

TPHd was detected in MW-5.20 at a concentration of 0.084 mg/L, which is less than the RWQCB taste and odor objective of 0.1 mg/L and the RBSC for aromatics (0.47 mg/L) and aliphatics (1.22 mg/L). TPHd was detected in MW-5.19 at 0.11 mg/L, just above the RWQCB taste and odor objective but less than the RBSC for aromatics and aliphatics. TPHd was not detected in wells MW-5.17, MW-5.18, and MW-5.21.

The area exceeding WQOs in the IRM and West of IRM AOIs of the OU-E groundwater AOC is limited to the vicinity immediately surrounding MW-5.20. During recent monitoring, this area is frequently below WQOs. MW-5.18 and MW-5.21 are actively monitored and are to the north and west of MW-5.20. Concentrations of TPHd at these locations have been below WQOs during recent monitoring. MW-5.17 and MW-5.19 were monitored in the past, have typically been near or below the WQOs during recent monitoring, and were approved for destruction by DTSC (DTSC 2017) and subsequently destroyed in November 2017. MW-5.3, MW-5.4, MW-5.5, MW-5.13, and MW-5.15 were monitored in the past but monitoring was stopped at each of these locations because TPHd was not detected above WQOs during the most recent monitoring timeframes at those locations. The approximate area surrounding MW-5.20 where TPHd is periodically above WQOs is approximately 20,000 sf for alternative development.

Barium has historically been detected at concentrations greater than the WQO of 1,000 mg/L at MW-4.1. In February 2017, barium was detected in monitoring well MW-4.1 at a concentration of 970 mg/L, which is less than the WQO. MW-4.1 is surrounded to the west, north, and east by wells MW-4.6, MW-4.5, MW-4.3, MW-4.3R, and MW-4.4 and to the south by Ponds 7 and 8. Barium has not been detected above WQOs in the monitoring wells surrounding MW-4.1. The approximate area surrounding MW-4.1 where barium is above the WQO is approximately 20,000 sf for alternative development.

4.2.3.3 Area for Remedial Alternative Development

Groundwater in the IRM AOI, West of IRM AOI, and OU-E Lowlands AOI will be evaluated collectively to develop remedial alternatives.

Section 5: Identification and Screening of Remedial Technologies and Process Options

In accordance to the FS process as described by USEPA's Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (referred as FS Guidance, USEPA 1988a), remedial alternatives are developed by assembling combinations of technologies, based on the media to which they would be applied, into alternatives that address contamination at a site. In addition to the first step which included the development of RAOs described in Section 3, the FS process consists of five additional general steps including the following, as discussed through the remainder of this FS:

- Develop GRAs for each medium of interest defining remedial actions that may be taken to satisfy RAOs (Section 5.1)
- Identify volumes or areas of media to which GRAs might be applied (Section 5)
- Identify and screen the technologies applicable to each GRA to eliminate those that cannot be technically implemented at the site (Section 5.2)
- Identify and evaluate technology process options to select a representative process for each technology type retained for consideration (Section 5.2)
- Assemble the selected representative technologies into alternatives representing a range of treatment and containment combinations, as appropriate, for evaluation and comparison (Sections 6, 7, 8 and 9).

This section details the development of GRAs and selection process of the potential remedial technologies for site soil, sediment, and groundwater. The purpose of the preliminary screening is to select remedial technologies or combinations of technologies that can be technically implemented at the site. Any treatability testing that may be required for those technologies that are probable candidates for consideration is also identified during this initial screening.

5.1 General Response Actions

GRAs are categories of actions that, when implemented, will allow meeting of RAOs established for the site, and provide a basis for identifying specific remedial technologies and process options. GRAs are developed for each medium of interest and define remedial actions that may, as standalone or in combination, be taken to satisfy the RAOs for the site. For the site, GRAs for soil, sediment, and groundwater have been considered.

The GRAs that have been considered for remediation of site soil are as follows:

- No action
- Institutional controls (ICs)
- Containment
- In-situ treatment
- Ex-situ treatment
- Removal

The GRAs that have been considered for remediation of site sediment are as follows:

- No action
- ICs
- Containment
- In-situ treatment
- Ex-situ treatment
- Removal

The GRAs that have been considered for remediation of site groundwater are as follows:

- No action
- ICs
- Monitored natural attenuation (MNA)
- Containment
- In-situ treatment
- Ex-situ treatment

Specific process options within each GRA are described and screened based on technical implementability in the following sections and in Tables 6-1 and 6-2.

5.2 Identification and Screening of Technologies and Process Options

As discussed previously, the identification and screening of technologies and process options is developed in two steps. The first step is to develop a short-list of remedial technologies and process options that are technically implementable for remediation of the target COCs within each media of interest. The second step is to further evaluate and refine technologies and process options based on effectiveness, implementability (e.g., institutional) and relative cost. Following the completion of the identification and screening process, each retained technology and associated process option will be further evaluated.

5.2.1 Preliminary Identification and Screening of Technologies and Process Options

The preliminary identification and screening criterion (or evaluation criterion) for remedial technologies and their associated process options is technical implementability. The screening for technical implementability is based on 1) the site-specific RAOs and ARARs, 2) site-specific conditions, such as the geologic setting and contaminant distribution, and 3) contaminant characteristics. During the preliminary identification and screening process, remedial technologies that cannot be technically implemented are eliminated from further evaluation.

5.2.1.1 Soil Remedial Technologies

The preliminary identification and screening process of remedial technologies and associated process options for treatment of soil at the site are discussed in this section and summarized in

Table 5-1. The following remedial technologies and associated process options for soil were identified and evaluated based on technical implementability:

- No action
- ICs
- Containment: cover in place with soil, geosynthetics, asphalt, or other capping materials
- In-situ physical treatment: in-situ soil mixing, soil vapor extraction (SVE), multi-phase extraction (MPE), thermal treatment
- In-situ biological treatment: mycoremediation
- In-situ chemical treatment: in-situ chemical oxidation (ISCO)
- Ex-situ physical/biological treatment: landfarming, biopiling
- Removal: excavation and offsite disposal.

In order to provide a baseline for comparison of alternatives as required by the National Oil and Hazardous Substances Contingency Plan (NCP, USEPA 1990), the “No Action” technology has been retained for all media. ICs, such as land use restrictions, have been retained to provide protection of human health and the environment through administratively restricting land use until chemical-specific clean up goals are met.

A barrier or cover is a containment process option that prevents exposure of potential receptors to affected media. A cover would effectively restrict the potential risk to receptors in accordance with RAOs until cleanup goals are achieved; therefore, covers are retained for incorporation in remedial alternatives.

In-situ soil mixing encapsulates contaminants in solidified media by in-situ mixing of impacted soil with solidifying reagents (e.g., cement, bentonite). This process option does not destroy COCs, but incorporates them into a dense, homogeneous, low-permeability structure that reduces concentrations and mobility. In-situ mixing can be implemented in the target AOCs and is retained for further evaluation.

SVE, also known as soil venting or vacuum extraction, is an in-situ treatment process option commonly used to remove volatile and certain semivolatile organic compounds in vapor from vadose zone soils. Similarly, MPE and thermal remediation rely upon volatilization and capture of COCs to achieve mass reduction. Based on contaminant characteristics in the areas identified in Section 5, SVE, MPE, and thermal remediation are retained for further evaluation of process options in soil.

A laboratory study of mycoremediation was prepared by NewFields for use of mushrooms and fungi to remediate dioxins and furans at the Site (NewFields, 2011). The primary objective of this study was to evaluate the potential for various strains of fungi to degrade dioxins/furans in site soils to determine whether mycoremediation could be an effective remedial process option at the site. A total of 30 fungal strains were evaluated for growth potential using site soils and sediments; nine of these fungal strains were collected from the site. The 10 strains that showed the greatest growth potential in site soils and sediments were selected for the dioxin/furan degradation phase of the study. Comparison of analytical results for spiked samples containing fungi to spiked control samples not containing fungi found no discernable degradation of dioxins/furans after incubation. Based on these results, mycoremediation has been determined to not be a viable remedial process option for dioxins/furans in soils at the site and will not be carried forward for further evaluation.

ISCO technology involves reduction/oxidation reactions that chemically convert hazardous contaminants to non-hazardous or less toxic compounds that are more stable or inert. One reactant is oxidized (loses electrons) and another is reduced (gains electrons). ISCO can be utilized for COCs identified in the AOCs and is retained for further evaluation.

Land farming is an ex-situ process option that consists of spreading the excavated soils in windrows to stimulate aerobic microbial activity through aeration and/or the addition of minerals, nutrients, and moisture to expedite treatment. Biopiling is an ex-situ process option that involves heaping COC-impacted excavated soils into aboveground storage cells and stimulating aerobic microbial activity via aeration and/or addition of minerals, nutrients, and moisture. The biodegradation induced by biopiling is likely effective for VOCs and semi-volatile organic compounds (SVOCs); therefore, both options are retained for further evaluation.

Removal (i.e., excavation) provides immediate and complete removal of impacted soil from the site to achieve RAOs and was retained for further consideration.

5.2.1.2 Sediment Remedial Technologies

The preliminary identification and screening process of remedial technologies and associated process options for treatment of sediment at the site are discussed in this section and summarized in Table 5-2. The following remedial technologies and associated process options for sediment were identified and evaluated based on technical implementability:

- No action
- ICs and natural recovery
- Containment: covers with sand, gravel, or other suitable materials, or structures such as a dam or berm
- In-situ physical treatment: in-situ soil mixing
- In-situ biological treatment: mycoremediation, in-situ biological oxidation (ISB)
- In-situ chemical treatment: ISCO
- Ex-situ physical/biological treatment: landfarming, biopiling
- Removal: excavation and offsite disposal.

In order to provide a baseline for comparison of alternatives as required by the National Oil and Hazardous Substances Contingency Plan (NCP, USEPA 1990), the “No Action” technology has been retained for all media.

ICs, such as land use restrictions, along with natural recovery, have been retained to provide protection of human health and the environment through administratively restricting land use until chemical-specific cleanup goals are met. Natural recovery is the process of degradation or transformation of a COC into less toxic compounds or forms. Sediment COC concentrations and bioavailable fractions decline naturally through existing biological and geochemical processes. Molecules of organic COCs degrade and transform into simpler and less toxic compounds via biological and geochemical processes. Metals such as arsenic and recalcitrant compounds such as PAHs transform from bioavailable species and accessible forms into less available forms through precipitation and combination with available minerals such as iron oxide complexes and sequestration by binding to organic carbon molecules, making them unavailable to potential receptors. These natural recovery processes are present in aquatic sediment at the site and are documented in the BHHERA via arsenic speciation testing and carbon equilibrium partitioning (EqP) modeling. Further, geomorphological and biological cycles in the ponds generate additional sediment mass through inputs from erosion and accumulation of organic material from biological growth and decay. Additions of new sediment minerals and organic carbon subsequently result in diffusion and dispersion of residual COC concentrations over time.

A cover would be implemented as a vegetated barrier to cover sediments in the ponds to restrict exposure of potential receptors to affected media. A cover would effectively restrict the potential risk to receptors in accordance with RAOs until cleanup goals are achieved; therefore, covers are retained for incorporation in remedial alternatives.

Containment can also be achieved via a dam or berm. The existing Mill Pond Dam and beach berm currently act as containment structures, keeping sediment in place and protecting sediment from storms, erosion, tsunamis, and sea-level rise.

On-site consolidation in a lined cell may not be acceptable within the Coastal Zone and has other issues with implementability. Section 30233 of the Coastal Act limits allowable use for wetland fill to seven specific uses. Consolidating contaminants within a wetland is not included within the listed allowable uses for wetland fill. Also, past experience with consolidation of contaminants at the former Mill Site demonstrated the difficulty with implementing this type of process option; therefore, on-site consolidation has not been retained for further evaluation.

Mycoremediation within the Pond AOIs with impacts to sediment is not feasible as the sediments are typically submerged. Further, mycoremediation was not shown to be effective in previous studies.

Implementation of in-situ soil mixing may pose difficulties due to accessibility restrictions for construction equipment; however, various modifications of the technology exist to adapt to site conditions. In-situ mixing can be implemented in the target AOCs and is retained for further evaluation.

ISB involves injection of substrates into the target media to promote biological degradation of target COCs. ISB relies upon reactions within the aqueous phase, which would occur within the pore space of the target sediments. As discussed above, ISCO relies upon abiotic reactions between reagents and target COCs to achieve mass reduction. Technical implementability concerns exist with both technologies, as well installation or direct push injections activities to deliver reagents will be restricted for sediments located in pond areas. In addition, achieving significant distribution of reagents is likely not feasible within fine-grained matrices characteristic of the sediments at the site. ISB and ISCO are not retained for further evaluation.

Land farming and biopiling can both be readily implemented for COCs in sediment; therefore, both options are retained for further evaluation.

Removal (i.e., excavation) provides immediate and complete removal of impacted sediment from the site to achieve RAOs and is retained for further consideration.

5.2.1.3 Groundwater Remedial Technologies

The preliminary identification and screening process of remedial technologies and associated process options for treatment of groundwater at the site are discussed in this section and summarized in Table 5-3. The following remedial technologies and associated process options with regarding to each GRA for remediating groundwater were identified and evaluated based on technical implementability:

- No action
- ICs
- MNA
- Hydraulic containment: diversion barriers
- In-situ physical treatment: Air Sparge (AS) & SVE, thermal treatment
- In-situ biological treatment: enhanced aerobic bioremediation, enhanced anaerobic bioremediation, phytoremediation
- In-situ chemical treatment: ISCO, permeable reactive barrier (PRB)
- Ex-situ treatment: pump and treat and reinjection, pump and treat and disposal.

In order to provide a baseline for comparison of alternatives as required by the NCP (USEPA 1990), the “No Action” technology has been retained for all media. ICs, such as land use controls, have been retained to provide protection of human health and the environment through administrative striction of groundwater use until chemical-specific ARARs are met. MNA has been retained to be used as a standalone technology or in conjunction with other more aggressive remedial technologies as a polishing step subsequent to active treatment.

Diversion barriers are engineered controls constructed to contain groundwater within the AOC and divert ambient groundwater around the impacted zone until cleanup goals have been met. Diversion barriers are readily implemented at the site through a variety of construction techniques and are retained for further consideration.

Air sparging relies upon injection of air into the saturated interval to promote mass transfer of volatile constituents to the vapor phase and is complemented with recovery through SVE in the vadose zone. Similarly, thermal remediation relies upon heating groundwater using a variety of technologies to enhance volatilization of constituents and capturing COCs with SVE. Air sparging and thermal remediation are readily implementable for fuel constituents in groundwater in the IRM and West of IRM AOIs and are retained for further evaluation.

Enhanced aerobic and anaerobic bioremediation rely upon the injection of reagents into the subsurface through permanent wells or temporary points to enhance biological degradation of

COCs. Both anaerobic and aerobic degredation pathways have been established and proven effective for fuel constituents in groundwater. Bioremediation is readily implementable across the target areas and is retained for further evaluation.

ISCO technologies, including oxidation processes using Fenton's reagent, persulfate, and permanganate as oxidants, are proven technologies for treatment of VOCs in groundwater and have been retained for further consideration. A PRB is a subsurface emplacement of reactive materials that extend below the water table to intercept and treat contaminated groundwater, typically under natural hydraulic gradient. A PRB is technically feasible at the site and is retained for further evaluation.

Groundwater recovery with treatment and reinjection and groundwater recovery with treatment and disposal are both proven and effective means for groundwater treatment and are retained for further evaluation.

5.2.2 Evaluation of Technology Types and Selection of Representative Process Options

Following completion of the preliminary screening based on technical implementability, the retained remedial technologies and associated process options are to be further evaluated in greater detail based on effectiveness, implementability (i.e., administrative), and relative cost.

In terms of effectiveness, remedial technologies and process options are evaluated by the following:

- Potential effectiveness in addressing the estimated areas and volumes of media and meeting the RAOs
- Potential health and safety concerns for the remedial action or potential impacts to the environment during construction and implementation
- How proven and reliable the process is with respect to the types of contamination and site conditions that will be encountered.

Implementability encompasses both the technical and institutional feasibility of implementing a technology process. As discussed in Section 5.2.1, technical implementability is used as an initial screening of technology types and process options to eliminate those that are clearly ineffective or infeasible for a site. Therefore, this subsequent evaluation places greater emphasis on the institutional aspects of implementability, such as the ability to obtain necessary permits for offsite actions, the availability of treatment, storage, and disposal services (including capacity), and the availability of necessary equipment and skilled workers to implement the technology (USEPA 1988a).

Cost plays a limited role in the evaluation of process options at this step. Relative capital and operations and maintenance (O&M) costs are used rather than detailed estimates. Each process option is evaluated on the basis of engineering judgment as to whether costs are high, moderate, or low relative to the other process options of the same remedial technology type.

Tables 5-1 through 5-3 present the screening of technologies and process options retained in the preliminary screening step, based on effectiveness, implementability, and relative cost for soil, sediment, and groundwater.

5.2.2.1 Detailed Screening of Soil Process Options

The detailed screening of process options for treatment of soil at the site are discussed in this section and summarized in Table 5-1.

The “No Action” technology continued to be retained to provide a comparative baseline. ICs have been retained to provide protectiveness through administrative actions until chemical-specific ARARs are met. Covers are retained because they effectively limit exposure and protect current and future receptors until ARARs are met.

Of the in-situ physical process options, SVE, MPE, and thermal remediation all rely upon construction of an aboveground treatment system to treat extracted vapors. Successful implementation of SVE is limited to COCs with sufficient volatility to be removed in the vapor phase. Due to the variability of COCs triggering exceedances within each AOC indicated in Section 5, SVE, MPE, and thermal remediation will not be effective at remediating the AOC in its entirety. The capital cost associated with treatment system installation is too expensive per level of effectiveness on a comparative basis to be considered for partial implementation. SVE, MPE, and thermal remediation will not be carried forward for further evaluation. In-situ soil mixing provides effective mitigation of risks to receptors and is applicable to all COCs within each AOC; therefore, in-situ soil mixing is retained for evaluation.

The only in-situ treatment option, ISCO, is only potentially effective for a small portion of COCs in soil, and the overall effectiveness must be evaluated by treatability test or bench scale study. Chemical oxidation of soil also may result in secondary water quality effects as byproducts are typically formed during activation and redox reactions and leaching of metals may occur. Additionally, reaction of the reagents with target COCs occurs in the aqueous phase; therefore, contaminant reduction in soils is highly dependent on sufficient contact with soil moisture in the pore space. Considering implementability concerns and the potential for generation of byproducts, ISCO is not retained for further evaluation.

Excavation and land farming is readily implementable and effective for reduction of volatile COCs. Land farming may be a cost-effective alternative to offsite disposal; therefore, land farming is retained for further evaluation.

Biopiling is a similar process option that relies upon stimulation of bacteria within aboveground storage cells to promote bioremediation of COCs. Biopiling would require a bench-scale study and/or a pilot test prior to the determination of site-specific effectiveness and design development. Biopiling is not retained for further development and evaluation due to the associated uncertainty and comparative moderate to high costs compared to other ex-situ treatment/disposal methods.

Excavation and disposal has been retained for treatment of soil because it is immediately effective and readily implementable. When compared to other technologies, excavation and disposal may have a higher capital cost but represents a lower risk as all COCs are removed offsite. Excavation and disposal are retained for further evaluation.

5.2.2.2 Detailed Screening of Sediment Process Options

The detailed screening of process options for treatment of sediment at the site are discussed in this section and summarized in Table 5-2.

The “No Action” technology continued to be retained to provide a comparative baseline. ICs have been retained to provide protectiveness through administrative actions until chemical-specific ARARs are met. A cover is retained as a process option to restrict access until cleanup goals are achieved.

As discussed previously, mycoremediation was not found to be effective at reducing COC concentrations in sediments during historical bench-scale tests. Based on these results, mycoremediation has been determined to not be a viable remedial process option and will not be carried forward for further evaluation.

Previous treatability tests of in-situ soil mixing have been conducted at the site to evaluate the technical feasibility and the effectiveness at reducing COC accessibility to receptors. Results of the treatability test indicate that due to high sediment organic and moisture content and poor post-treatment strength results, in-situ soil mixing requires significant volumes of binders and Portland cement to be effective. In-situ soil mixing will be retained for further evaluation.

Landfarming and biopiling both rely upon biological treatment of COCs to achieve effective mass reduction. Based on the nature of COCs driving risk within the sediment AOIs, biological treatment will not be sufficient to reduce COC concentrations to meet target cleanup goals and achieve RAOs. Landfarming and biopiling are not retained for further evaluation for sediment.

Excavation and disposal has been retained for treatment of sediment because it is immediately effective and readily implementable. When compared to other technologies, excavation and disposal may have a higher capital cost but represents a lower risk as all COCs are removed offsite. Excavation and disposal is retained for further evaluation.

5.2.2.3 Detailed Screening of Groundwater Process Options

The detailed screening of process options for treatment of groundwater at the site are discussed in this section and summarized in Table 5-3.

The “No Action” technology continues to be retained to provide a comparative baseline. ICs have been retained to provide protectiveness through administrative actions until chemical-specific ARARs are met. MNA, which is effective, readily implementable, and has low capital cost (i.e., using existing monitoring well network) and low O&M cost, has been retained to be used in conjunction with other treatment technologies.

Hydraulic containment is applied to groundwater/soil when there is a risk of dispersion to uncontaminated areas. It can be applied as a stand-alone technology when passive containment is sufficient or can be combined with other technologies such as groundwater pump and treat systems. Diversion barriers are effective for containment of the groundwater plume if contaminant mobility is of significant concern. Since the IRM were conducted as discussed in Section 2.2.3, groundwater conditions in the vicinity of the OU-E Groundwater AOC have remained relatively stable. Given the nature and extent of COCs in the OU-E

Groundwater AOC, installation of diversion barriers will not likely meet RAOs and will likely not provide a significant advantage when implemented in conjunction with another remedial technology and will not be further evaluated in this FS.

AS/SVE and thermal remediation both present physical removal processes for removing COCs by volatilization and recovery. Both technologies can be effective for mass removal in groundwater; however, thermal remediation requires significant capital and O&M costs for implementation. Additionally, thermal remediation poses several health and safety and permitting concerns for implementation. Further, due to the low volatility of diesel phase petroleum hydrocarbon COCs, AS/SVE is unlikely to provide meaningful removal of residual diesel fuel mass. Based on the comparison of physical process options, AS/SVE and thermal options are not retained for further consideration.

Enhanced aerobic and anaerobic bioremediation are effective and implementable for remediation of VOCs and other fuel-related constituents. Both process options rely upon injection of a variety of reagents to enhance the attenuation of target COCs. Based on their proven effectiveness in areas with petroleum-related impacts, enhanced aerobic and anaerobic bioremediation are retained for further evaluation.

Phytoremediation is a passive biological treatment technology that utilizes vegetation to address a wide range of contaminants. For groundwater impacted by petroleum hydrocarbons, rhizodegradation is often the primary mechanism used to enhance microbial biodegradation of contaminants. Given the average depth of groundwater near the OU-E Groundwater AOC, a tree/shrub plantation with roots extending 10 to 15 feet bgs would likely be the main application for treatment. The effectiveness of phytoremediation at the site is unknown and would require treatability studies to establish remedial timeframes. Given the uncertainty associated with the remedial approach in achieving RAOs, phytoremediation is not retained for further evaluation.

Hydrocarbon degradation through ISCO is an established technology that can be effective utilizing several chemical reagents and delivery methods. Redox reactions can generate a variety of byproducts that can enhance natural attenuation through biological pathways, similar to anaerobic bioremediation. Based on the relatively low concentrations of residual petroleum hydrocarbons, ISCO reactions are likely to result in more severe secondary water quality affects than current COCs in groundwater. ISCO is not retained for further evaluation.

A PRB relies upon the ambient groundwater flux to reduce concentrations of COCs within the constructed treatment zones. The majority of trench-installed PRBs use zero-valent iron as the reactive medium for converting contaminants to non-toxic mediums, however, other mediums such as limestone, granular activated carbon (GAC), zeolites, and various carbon sources (e.g., compost) have also been deployed in PRBs to treat metals and some organic compounds (Interstate Technology & Regulatory Council, 2005). PRBs utilize similar degradation pathways as other in-situ process options; however, the effectiveness is tied to groundwater flushing across the AOC. Additionally, permitting of permanent reactive barriers within the Coastal Zone may pose significant implementation challenges. Based on effectiveness and administrative considerations, PRBs are not retained for further evaluation.

Pump and treat process options rely upon extraction of groundwater and treatment on-site followed by either reinjection or disposal. Ex-situ treatment can be conducted through a variety of technologies including air stripping and adsorption using granular organic carbon. Both technologies are proven to effectively treat hydrocarbons and both are feasible at the site. Both process options would require permitting with state and local agencies; however, on-site disposal is more readily implemented if treated water is discharged to Pond 8. Pump and treat options rely on the ability to remove mass in the dissolved phase in sufficient quantity to have an affect on groundwater quality. Based on current and anticipated site conditions and relatively low concentrations, low mass removal is not likely to result in measurable changes in site conditions, pump and treat and disposal are not retained for further evaluation.

5.2.3 Description of Selected Process Options

This section presents general descriptions of selected remedial technologies and process options for all onsite media. To avoid repetition, technologies and process options that are specific to all media are presented in Section 5.2.3.1 (Site-Wide Process Options). Technologies and process options that are specific to soil, sediment, and groundwater are presented in Sections 5.2.3.2 through 5.2.3.4.

5.2.3.1 Site-Wide Process Options

Site-wide remediation process options included in this evaluation are applicable to soil, sediment, or groundwater media at each of the AOIs and are discussed below and provided in Tables 5-1 through 5.3.

5.2.3.1.1 No Action

The NCP requires that a No Action alternative be evaluated in an FS to serve as a baseline for comparison purposes, as described in Section 5.2.1.1. A No Action alternative will be developed for all soil, sediment, and groundwater AOCs.

5.2.3.2 Soil Process Options

Soil remediation process options included in this evaluation are discussed below and provided in Table 5-1.

5.2.3.2.1 Institutional Controls: Land Use Controls, Soil Management, and Long-Term Operations and Management

Institutional controls include a variety of measures designed to restrict current and future property owners from taking actions that would expose potential receptors to unacceptable risk, interfere with effectiveness of the final remedial action, and/or convert the site to an end use that is not consistent with the level of remediation. The primary objective of institutional controls is to limit potential for exposure to COCs by restricting access to impacted areas.

For soil, this technology would protect human health by assigning LUCs to prevent the potential risk of receptors encountering COC-impacted soil. A soil management plan (SMP) would be developed based on COCs and associated risks to further protect potential future receptors. Implementing institutional controls is possible given current site conditions, and the overall cost is relatively low.

5.2.3.2.2 Covers

A barrier or cover is a containment process option that prevents exposure of potential receptors to affected media. A cover can be constructed of pavement materials such as concrete or asphalt, clean soil protected from erosion by vegetated growth or other erosion control measures, or an engineered cover or structure that may include low permeability materials or liners. The cover layer may consist of clean material that is already in place above affected media and is restricted from being removed. The cover layer may limit potential direct contact with affected soils, migration of vapors, or infiltration of water. Given the foreseeable future use of the site and habitat status, a vegetated cover will be the type of cover considered for implementation as a vegetated cover can provide long-term enhancement of ecological habitat.

A vegetated cover system does not pose significant risk to human health or the environment during construction or operational period. Installation of a vegetated cover is a proven and effective method of providing an exposure barrier. LUCs may be used to require that redevelopment design add, modify, or maintain covers appropriate for the future (and possibly different) use of specified areas at the time of future construction. Installation of a cover would be relatively simple to implement and can be completed with standard construction equipment and methods. Implementation is considered comparatively low in cost.

Containment can also be achieved via a dam or berm. The existing Mill Pond Dam and beach berm currently act as containment structures, keeping sediment in place and protecting sediment from storms, erosion, tsunamis, and sea-level rise. These structures are current containment structures for Ponds 6, 7, 8, and the North Pond.

5.2.3.2.3 In-situ Soil Mixing

ISM technology can be used to immobilize organic and inorganic compounds in saturated and vadose zone soil, using reagents to produce an inert, geotechnically strong, and relatively less permeable material, such as Portland cement. This process option does not destroy COCs, but incorporates them into a dense, homogeneous, low-permeability structure that reduces concentrations and mobility. In-situ mixing can be performed with an excavator bucket or a large diameter crane-mounted auger depending on depth and volume. Onsite air monitoring for dust, vapor, and odor control to protect workers and the public would be typical during implementation.

Because Portland cement will be added to the soil, the volume of treated soil will be greater than the original material volume. In order to account for bulking, excess material would be tested and used for backfill elsewhere at the site or transported offsite for disposal.

5.2.3.2.4 Land Farming

Land farming is an ex-situ treatment technology that consists of spreading the excavated soils in windrows to stimulate aerobic microbial activity through aeration and/or the addition of minerals, nutrients, and moisture to expedite treatment. The windrows are regularly tilled to enhance volatilization. Land farming is sensitive to environmental conditions and would likely require a bench-scale study and/or pilot test prior to the determination of site-specific effectiveness and design development. The biodegradation induced by land farming is likely effective for VOCs and SVOCs, but land farming may not be effective for heavier and more persistent COCs such as metals or chlorinated solvents (USEPA, 1994).

5.2.3.2.5 Excavation and Disposal

Excavation involves the physical removal of soil using standard excavation practices and equipment. Typical equipment used includes excavators, backhoes, drag lines, clamshells, vacuum trucks, and front-end loaders. Excavated soil is transported to a landfill offsite and is required to meet federal and state transportation and disposal regulations. Backfilling, grading, and revegetation are performed following excavation. Sampling and analysis of the backfill material source is typically performed to determine the acceptability of the backfill material. Given the nature and distribution of COC-impacted soil, hotspot excavation of designated PRAs is sufficient to meet RAOs and will be considered in preference to full excavation of all COC-impacted media.

Excavation and removal of affected soil is protective of human health and the environment. However, excavation carries a higher risk to the health and safety of workers. Onsite air monitoring and dust, vapor, and odor control provisions would be necessary during excavation operations to avoid the release of fugitive dusts and runoff from disturbed soil. Dust controls could include water sprays or application of chemical dust suppressants. Surface water controls may also be required.

5.2.3.3 Sediment Process Options

Sediment remediation process options included in this evaluation are discussed below and provided in Table 5-2.

5.2.3.3.1 Institutional Controls: Containment, Land Use Controls, Sediment Management, and Long-Term Operations and Management

Institutional controls include a variety of measures designed to restrict current and future property owners from taking actions that would expose potential receptors to unacceptable risk, interfere with effectiveness of the final remedial action, and/or convert the site to an end use that is not consistent with the level of remediation. The primary objective of institutional controls is to limit potential for exposure to COCs by restricting access to impacted areas.

For sediment, this technology would protect human health by assigning LUCs to prevent the potential risk of receptors encountering COC-impacted sediment. An SMP would be developed based on COCs and associated risks to further protect potential future receptors. Implementing institutional controls is possible given current site conditions, and the overall cost is relatively low.

5.2.3.3.2 Covers

A barrier or cover is a containment process option that prevents exposure of potential receptors to affected media. Within the context of sediment, a barrier is primarily implemented in the form of a vegetated barrier.

A vegetated cover system does not pose significant risk to human health or the environment during construction or operational period. Installation of a vegetated cover is a proven and effective method of providing an exposure barrier. LUCs may be used to require that redevelopment design add, modify, or maintain covers appropriate for the future (and possibly different) use of specified areas at the time of future construction. Installation of a cover would be relatively simple to implement and can be completed with standard construction equipment and methods. Implementation is considered comparatively low in cost.

Containment can also be achieved via a dam or berm. The existing Mill Pond Dam and beach berm currently act as containment structures, keeping sediment in place and protecting sediment from storms, erosion, tsunamis, and sea-level rise. These structures are current containment structures for Ponds 6, 7, 8, and the North Pond.

5.2.3.3.3 In-situ Soil Mixing

ISM technology can be used to immobilize organic and inorganic compounds in saturated sediments, using reagents to produce an inert, geotechnically strong, and relatively less permeable material, such as Portland cement. This process option does not destroy COCs, but incorporates them into a dense, homogeneous, low-permeability structure that reduces concentrations and mobility. In-situ mixing can be performed with an excavator bucket or a large diameter crane-mounted auger depending on depth and volume. Onsite air monitoring for dust, vapor, and odor control to protect workers and the public would be typical during implementation.

Because Portland cement will be added to the sediment, the volume of treated material will be greater than the original material volume. In order to account for bulking, excess material would be tested and used for backfill elsewhere at the site, or transported offsite for disposal. Use of Portland cement in aquatic environments is generally not accepted without significant mitigation and the areas treated could not remain aquatic environments due to elevated pH and the loss of suitable habitat materials.

5.2.3.3.4 Excavation and Disposal

Excavation of sediment relies upon similar methods of removal as excavation of soils; however, additional consideration is required to address access restrictions and dewatering. Excavation may require the need for long-stick excavators and potential engineered controls adjacent the excavation to support equipment during removal. Dewatering of excavated sediment is required to reduce the moisture content prior to transportation and disposal. After dewatering, excavated sediment is transported to a landfill offsite and is required to meet federal and state transportation and disposal regulations. Restoration following excavation of sediments may require backfilling and revegetation to restore existing habitat.

5.2.3.4 Groundwater Process Options

Groundwater remediation process options for the OU-E Groundwater AOC included in this evaluation are discussed below and provided in Table 5-3.

5.2.3.4.1 Institutional Controls: Groundwater Restrictions and Long-Term Operations and Management

Institutional controls include a variety of measures designed to restrict current and future property owners from taking actions that would expose potential receptors to unacceptable risk, interfere with effectiveness of the final remedial action, and/or convert the site to an end use that is not consistent with the level of remediation. The primary objective of institutional controls is to limit potential for exposure to COCs by restricting access to impacted areas.

For groundwater this technology can be implemented by applying groundwater use restrictions within the AOC. Groundwater use restrictions are incorporated into the property deed(s) and may limit the locations and types of allowable groundwater use at the site. Groundwater use restrictions do not physically alter conditions at the site and do not, or are not intended to, reduce the mobility, toxicity, or volume of COCs at the site as part of the remedial process option. The primary objective of groundwater restrictions is to eliminate potential for exposure to COCs by restricting access to affected groundwater.

5.2.3.4.2 Monitored Natural Attenuation

MNA entails monitoring to confirm that COC concentrations are attenuating over time via natural subsurface processes such as dilution, dispersion, volatilization, biodegradation, adsorption, and abiotic chemical reactions. Intrinsic biodegradation is generally the dominant attenuation mechanism.

The primary objective of the evaluation and subsequent MNA implementation is to demonstrate that natural processes of COC degradation will reduce concentrations below regulatory standards before potential exposure pathways are completed. Data may be used to demonstrate that attenuation processes are occurring and to calculate an approximate time to reach cleanup objectives. During MNA, sampling and sample analysis is conducted periodically throughout the process to confirm that degradation is proceeding at rates consistent with fate and transport interpretations and the established cleanup objectives.

5.2.3.4.3 Enhanced Aerobic Bioremediation

Enhanced aerobic bioremediation degrades COCs in the subsurface by enhancing the natural microbial biodegradation processes by delivering oxygen as an electron acceptor to the subsurface. In microbial degradation, microbes derive energy by transferring electrons from the carbon source to a suitable electron acceptor such as oxygen. Generally, there are sufficient quantities of carbon present but limited amounts of electron acceptors. Oxygen, the most energetically efficient electron acceptor, tends to become quickly depleted in the presence of sufficient carbon prompting the utilization of other electron acceptors by bacteria. Enhanced aerobic bioremediation would provide additional oxygen to augment microbial degradation.

Oxygen is typically added through sparging or diffusing gases, or direct-push of slurry solutions such as pure oxygen, calcium peroxide, or by injection of reagents containing dissolved oxygen or oxygen releasing compounds. For the purposes of this FS, direct-push injection of calcium peroxide reagent has been selected as an effective means of oxygen delivery for evaluation and will be further evaluated in this FS. Calcium peroxide is an oxygen-releasing compound when injected in slurry form via direct-push, serves as a slow-release source of oxygen due to its sparingly soluble nature in groundwater (less than 0.2% by weight). Calcium peroxide is oftentimes more cost effective than other name-brand oxygen-releasing materials in terms of cost per pound of oxygen delivered.

5.2.3.4.4 Enhanced Anaerobic Bioremediation

Enhanced anaerobic bioremediation degrades COCs in the subsurface by enhancing the natural microbial biodegradation processes by adding a non-oxygen electron acceptor in a low-oxygen or oxygen-free environment. Similar to enhanced aerobic bioremediation, enhanced anaerobic bioremediation augments microbial degradation, however, relies on redox couples other than oxygen (e.g., nitrate reduction, ferric iron reduction, sulfate reduction, and methanogenesis) to facilitate cellular respiration.

Injection of a non-oxygen electron acceptor to stimulate enhanced anaerobic bioremediation is likely to affect secondary water quality parameters in the short term. For example, sulfate has a secondary MCL of 250 mg/L based on aesthetic effects (i.e., taste and odor) and nitrate (as nitrogen) has a primary MCL of 10 mg/L. Due to the elevated nitrate dose required for treatment relative to the primary MCL, the preference to select an injection reagent with less potential for secondary water quality effects, and the relative similarity of these two electron acceptors in achieving treatment, sulfate is recommended as the preferred reagent.

During the enhanced anaerobic bioremediation process, sulfate is consumed and converted to sulfide. Free sulfide reacts readily with naturally-occurring ferrous iron that is also present in these systems to form iron-sulfide precipitates. While achieving an initial increase in sulfate concentrations is the intent following an injection, the concurrent delivery of sulfate materials with organic carbon will serve as the primary mechanism to limit the long-term permanence of sulfate within the treatment areas and prevent adverse effects on long-term groundwater chemistry.

Anaerobic processes generally occur at slower rates than those observed for aerobic processes; however, non-oxygen electron acceptors (i.e., sulfate) can be advantageous because they are highly soluble, can be supplied at elevated dissolved concentrations, and have minimal abiotic or non-target reactions that typically limit oxygen persistence in the subsurface. The solubility of sulfate associated with gypsum is approximately 2 grams per liter, which is more than enough to sustain enhanced anaerobic bioremediation, and approximately three orders of magnitude greater than the solubility of oxygen. Comparatively, aerobic remediation through injection of an oxygen-releasing substrate, such as calcium peroxide is fundamentally limited by low oxygen solubility in groundwater and multiple competing oxygen sequestration reactions. Additionally, aquifer pH in the immediate vicinity of the calcium peroxide application is anticipated to be elevated during the period of active treatment. Therefore, while the kinetic rates of anaerobic hydrocarbon bio-oxidation may be slower than under aerobic conditions, the ability to deliver elevated concentrations of non-oxygen electron acceptors over a relatively long-time period can be more effective in treating residual contaminants in groundwater.

Enhanced anaerobic bioremediation utilizing Epsom Salt (i.e., magnesium sulfide) will be incorporated into remedial alternative development in this FS.

Section 6: Identification of Screening Criteria

Remedial technologies retained through preliminary screening are now further developed and evaluated against applicable remedial alternative screening criteria. In accordance with USEPA FS and DTSC RAP guidance, the nine criteria described in the sections below must be used to evaluate remedial alternatives (USEPA, 1988; DTSC, 1995). For an alternative to be selected, it must meet the first two threshold Criteria, which are: 1) overall protection of human health and the environment; and 2) compliance with ARARs. Criteria 3 through 7 are the five primary balancing criteria that provide comparisons between the alternatives and identify tradeoffs between them; Criteria 8 and 9 are the two modifying criteria that consider acceptance by the state and local community.

6.1 Threshold Screening Criteria

Threshold screening criteria are those considered absolutely necessary for an alternative to be considered sound. These criteria reflect the overall protection of human health and the environment and compliance with ARARs. Threshold criteria are typically considered “yes or no” criteria. If a screened technology fails a threshold criterion, the technology is considered as not viable for further consideration.

6.1.1 Overall Protection of Human Health and the Environment

All remedial alternatives being evaluated must be protective of human health and the environment. No alternative should result in unacceptable levels of risk to onsite or offsite receptors during or after implementation, drawing upon the assessment of other evaluation criteria, including short- and long-term effectiveness and compliance with the RAOs. This component of the alternative evaluation assesses how potential exposure pathways are eliminated, reduced, or controlled through removal, treatment, engineering controls, or institutional controls.

6.1.2 Compliance with ARARs

The remedial alternatives must be evaluated to determine whether they comply with ARARs under federal environmental laws and state environmental or facility siting laws, or whether there are grounds for a waiver. ARARs are presented in Section 3.

6.2 Balancing Criteria

Balancing criteria represent a combination of technical measures and management controls for addressing the environmental issues at the site. These criteria have gradations in value. The balancing screening criteria emphasize short- and long-term effectiveness; implementability; cost; and reductions of toxicity, mobility, or volume through treatment. The balancing criteria also consider the preference for treatment as a principal element and the bias against offsite land disposal of untreated waste.

6.2.1 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence screening criterion evaluates the ability of an alternative to perform intended functions such as containment, diversion, removal, destruction or treatment, and the permanence of the remedy. This criterion also assesses protection of human health and the environment after the RAOs have been met (USEPA, 1988). In accordance with NCP guidance, the long-term effectiveness screening criterion includes the magnitude of residual risk from any untreated waste or treatment residuals remaining at the conclusion of remediation activities, and the adequacy and reliability of controls (such as containment systems and institutional controls) that are necessary to manage treatment residuals and untreated waste. This criterion may be evaluated by design specifications or performance evaluation.

6.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

The reduction of toxicity, mobility, and volume screening criterion evaluates the degree to which an alternative employs recycling or treatment options that reduce toxicity, mobility, or volume, including how treatment is used to address principal threats potentially posed by the site. Factors considered for this criterion include treatment process and volume of materials to be treated; ability of the treatment to reduce the toxicity, mobility, or volume of contamination; nature and quantity of residuals that would remain after treatment; relative amount of hazardous substances and/or constituents that would be destroyed, treated, or recycled; and the degree to which the treatment is irreversible (USEPA, 1988).

6.2.3 Short-Term Effectiveness

The short-term effectiveness screening criterion assesses the short-term impacts of alternatives by considering short-term risks that may be posed to the public and the potential impacts on workers during remedial action implementation. This criterion also evaluates the effectiveness and reliability of protective measures, potential impacts on the environment and the effectiveness and reliability of mitigative measures, and amount of time until protection is achieved (USEPA, 1988).

6.2.4 Implementability

The implementability screening criterion evaluates the technical and administrative feasibility of implementing the remedial alternative, including the availability of various services and materials required for implementation (USEPA, 1988). Implementability depends on factors such as constructability (e.g., physical setting, permitting, disposal options), duration of work, reliability of the technology, ease of operation, availability of services and materials, and ability to monitor effectiveness (USEPA, 1988).

6.2.5 Cost

The cost screening criterion compares the anticipated approximate costs, direct (construction and materials) and indirect (engineering and legal) capital costs, as well as O&M costs. O&M costs may include operating labor, energy, chemicals, and sampling and analysis. O&M assumptions for each alternative are noted in the text. These costs were estimated with an anticipated accuracy between -30 to +50 (USEPA, 1988), and are represented in 2017 dollars applying 30-year net present value for future costs where necessary.

6.3 Modifying Criteria

Modifying criteria, which include state (support agency) and community acceptance, will be evaluated after submission of the FS to DTSC and after submittal of a RAP and receipt of public comments. The modifying criteria are described below.

6.3.1 State Support/Agency Acceptance

This criterion indicates whether, based on current knowledge of regulations and agency mandates, the applicable regulatory agencies would agree with the preferred alternative. The rankings listed in the sections below are based on preliminary input from agency meetings and knowledge of regulatory mandates. Actual assessment of regulatory agency acceptance is dependent on comments received during the agency review and public comment periods.

6.3.2 Community Acceptance

This criterion indicates whether community concerns are addressed by the remedy. Each alternative is evaluated in terms of currently available public input and the anticipated public reaction to the alternative but is considered preliminary. However, actual assessment of community acceptance is dependent on comments received during public comment period of the draft RAP.

6.4 Other Criteria

California Health and Safety Code Section 25356.1(d) also outlines six additional criteria, which need to be addressed for the recommended remedial alternative. As these criteria are addressed within the nine USEPA criteria, a separate analysis has not been conducted.

Section 7: Development and Evaluation of Remedial Alternatives

As discussed previously, remedial alternatives are developed by combining remedial technologies and process options identified in Section 5 for groundwater, soil and sediment. Alternatives are presented below for each remediation area within OU-E. AOIs that were addressed in the OU-E RAW are discussed collectively.

Areas addressed in the RAW include Lowland Terrestrial Soil, Ponds 1 through 4 (Southern Ponds) Aquatic Sediment, Pond 7 Aquatic Sediment, and Riparian Aquatic Sediment, where excavation and disposal was approved and completed in 2017. An evaluation of remedial alternatives is provided in the RAW. The Lowland Terrestrial Soil AOI and Riparian AOI were approved for NFA (DTSC 2018a). AOCs evaluated in this FS and the remedial alternatives considered are summarized as follows:

- Southern Ponds (Ponds 1-4) Aquatic Sediment
  - No Action
  - Institutional Controls
  - Vegetated Soil Cover
  - Excavation and Disposal
  - Vegetated Sediment Cover
- Pond 7 Aquatic Sediment
  - No Action
  - Institutional Controls
  - Vegetated Soil Cover
  - Excavation and Disposal
  - Vegetated Sediment Cover
- North Pond and Pond 6 Aquatic Sediment
  - No Action
  - Institutional Controls
  - Vegetated Soil Cover
  - Excavation and Disposal
  - Vegetated Sediment Cover
- Pond 8 Aquatic Sediment
  - No Action
  - Institutional Controls
  - In-situ Soil Mixing
  - Excavation and Disposal
  - Vegetated Sediment Cover
  - Vegetated Soil Cover

- OU-E Groundwater
  - No Action
  - Restricted Use
  - MNA
  - Enhanced Aerobic Bioremediation
  - Enhanced Anaerobic Bioremediation

The remedial alternatives were compared against the nine screening criteria presented in Section 6 and are developed and evaluated in Section 7.

7.1 AOIs addressed in the RAW

7.1.1 Lowland Terrestrial Soil

A remedial action was presented in the approved OU-E RAW for this AOC. Implementation was completed in 2017. Approximately 1,477 cy were excavated over an area of 8,000 sf and disposed at an appropriate facility. Soil was excavated using conventional construction equipment and transported to an appropriate non-hazardous waste disposal facility. The excavation areas were backfilled with clean imported soil and compacted to the original surface elevation. Confirmation sampling was performed to confirm that concentrations at the excavation limits are below the not to exceed remedial goals included in the OU-E RAW and meet unrestricted land use goals. NFA was recommended for the Lowland Terrestrial AOI in the RACR and was approved by DTSC (DTSC 2018a). A summary of implementation and confirmation sample results are presented in the RACR.

7.1.2 Ponds 1 through 4 (Southern Ponds) Aquatic Sediment

A remedial action was presented in the approved OU-E RAW for this AOI. Implementation was completed in 2017. Approximately 45 cy were excavated over an area of 800 sf and disposed at an appropriate facility. Sediment was excavated using conventional construction equipment and transported to an appropriate non-hazardous waste disposal facility. Confirmation sampling was performed to confirm that concentrations at the excavation limits are below the not to exceed remedial goals included in the OU-E RAW. The need for additional sediment removal or land use controls will be evaluated based on the confirmation sampling results. A summary of implementation and confirmation sample results are presented in the RACR. Residual concentrations remain above unrestricted use screening criteria and, therefore, alternatives are also evaluated in the following sections.

7.1.3 Pond 7 Aquatic Sediment

A remedial action was presented in the approved OU-E RAW for this AOI. Implementation was completed in 2017. Approximately 708 cy were excavated over an area of 5,500 sf and disposed at an appropriate facility. Sediment was excavated using conventional construction equipment and transported to an appropriate non-hazardous waste disposal facility. The excavation areas were backfilled with soil removed from the wetland establishment area. Confirmation sampling was performed to confirm that concentrations at the excavation limits are below the not to exceed remedial goals included in the OU-E RAW. A summary of implementation and confirmation sample results will be presented in the RACR. Residual concentrations remain above unrestricted use screening criteria, and, therefore, alternatives are also evaluated in the following sections.

7.1.4 Riparian Aquatic Sediment

A remedial action was presented in the approved OU-E RAW for this AOI. Implementation was completed in 2017. Approximately 7 cy were excavated over an area of 370 sf and disposed at an appropriate facility. Confirmation sampling was performed to confirm that concentrations at the excavation limits are below the not to exceed remedial goals included in the OU-E RAW. Based on the confirmation sampling results, the Riparian Area meets unrestricted use remedial goals. NFA was recommended for the Riparian AOI in the RACR and was approved by DTSC (DTSC 2018a). A summary of implementation and confirmation sample results are presented in the RACR.

7.1.5 Threshold, Balancing, and Modifying Criteria

A comparison of the threshold, balancing, and modifying criteria was conducted for excavation and disposal, and is summarized below.

- **Threshold Criteria**
  - <u>Overall protectiveness of human health and the environment</u>: The COC-concentrations in soil, which drove the risk-based PRAs, will be directly removed and disposed of offsite in a permitted landfill. This remedial action will remove contaminated soil and sediment within these AOIs that may have an impact to human health and the environment, as confirmed by confirmation sampling and, therefore, human health and the environment are anticipated to be protected following implementation. This remedial action is ranked high for this criterion.
  - <u>Compliance with ARARs</u>: Excavation and disposal is in compliance with the ARARs.
- **Balancing Criteria**
  - <u>Long-term effectiveness and permanence</u>: No O&M is required for the excavation and disposal alternative, so it is considered effective in the long term. If necessary, based on evaluation after completion of the remedial action, site use and soil disturbing activities in the PRAs may be controlled by land use controls, further ensuring long-term effectiveness. Therefore, this remedial action is ranked high for this criterion.
  - <u>Reduction of toxicity, mobility, or volume</u>: Excavation and disposal will remove soil and sediment that exceeds the not to exceed goals presented in the OU-E RAW, thereby reducing the volume of contaminated soil and sediment. The remedial action will remove soil and sediment with high concentrations of the COCs, therefore reducing the toxicity and mobility of the COCs at the site. Overall, this remedial action is ranked high for this criterion.
  - <u>Short-term effectiveness</u>: The Excavation and Disposal alternative is ranked moderate for short-term effectiveness as construction workers would be temporarily exposed to COC-affected media during implementation. Administrative and engineering controls

would be in-place during excavation and disposal to provide protection to workers to limit any potential exposure pathways in the short term.

- Implementability: The Excavation and Disposal alternative is ranked high for implementability as it is readily implementable with standard construction equipment, backfilling materials would be locally obtainable, and waste likely qualifies as non-hazardous waste for reduced disposal hazards and transport.
- Cost: Excavation and disposal is ranked moderate as it is typically more expensive than other remedial alternatives. However, there are no O&M costs associated with excavation and disposal, which have more uncertainty than implementation costs and, therefore, there is less uncertainty for the excavation and disposal remedial action than other alternatives.

- **Modifying Criteria**
  - State and agency acceptance: The OU-E RAW has been approved by DTSC (DTSC, 2016) and, therefore, this remedial action is ranked high for this criterion.
  - Community acceptance: The OU-E RAW underwent a public review and comment period and all comments were addressed prior to approval. Therefore, this remedial alternative is ranked high for this criterion.

7.1.6 Future Remedial Action Plan

Following implementation of the OU-E RAW remedial action, the OU-E RAP will be prepared. The RAP will include a summary of the completed remedial actions, summarize areas approved for NFA, and assess if further action is required in remaining areas. Alternatives to be evaluated and the scenario in which they are likely to be recommended in the RAP include the following:

- LUCs: confirmation sampling indicates that remaining EPCs in soil and sediment exceed goals for unrestricted use but individual locations do not exceed the not to exceed goals.
- Additional soil/sediment removal, capping, treatment, or other contingency remedies: confirmation sampling indicates that remaining concentrations in soil and sediment exceed the not to exceed goals. This alternative will be considered but is not expected to be required because confirmation sampling indicates that the excavation limits are below the not to exceed goals.

Based on confirmation sampling results obtained during the RAW implementation, land use controls are anticipated to be sufficient to protect human health and the environment in the AOCs addressed in the RAW.

7.2 Southern Ponds AOC (Ponds 1 through 4) Aquatic Sediment

Remedial technologies for this AOC were preliminarily screened in Section 5.1 and summarized on Table 5-2. This section presents an evaluation of the selected alternatives for the Southern Ponds AOC based on the screening criteria presented in Section 6.

7.2.1 Development and Evaluation of Remedial Alternatives

7.2.1.1 Southern Ponds Aquatic Sediment: Alternative 1 - No Action

The No Action alternative is intended to serve as a baseline which to compare the risk reduction effectiveness of potential technologies, as required by USEPA and NCP regulations (USEPA, 1988). In this baseline, no remedial efforts would be performed. No efforts would be undertaken to contain, remove, or monitor any areas with impacted aquatic sediment at the site. The site would be maintained by Georgia-Pacific in its current condition for the foreseeable future. An evaluation of this alternative is provided in the following sections.

7.2.1.1.1 Overall Protection of Human Health and the Environment

The No Action alternative was retained per requirement of the NCP for baseline comparison and does not meet the threshold criteria. Although natural biodegradation would likely occur, no actions would be taken to monitor or confirm attenuation. Degradation may not occur within a reasonable timeframe, and thus the RAOs for unrestricted use are not met.

7.2.1.1.2 Compliance with ARARs

ARARs would not be met for the No Action alternative.

7.2.1.1.3 Long-Term Effectiveness and Permanence

As described in Section 7.2.1.1.1, the degradation rate is unknown and would not be monitored and, therefore, the RAOs for unrestricted use are not met. This alternative ranks low for long-term effectiveness and permanence.

7.2.1.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Although natural biodegradation would likely occur, no actions would be taken to monitor, and degradation may not occur within a reasonable timeframe, and thus no reduction of toxicity, mobility, or volume could be confirmed to justify potential long-term effectiveness. The No Action alternative ranks low for reduction of toxicity, mobility, or volume criteria.

7.2.1.1.5 Short-Term Effectiveness

The No Action alternative received a high ranking for the short-term effectiveness criteria – as no actions are being performed. Because no actions are being performed, the No Action alternative provides no additional short-term risks during implementation.

7.2.1.1.6 Implementability

The No Action alternative received a high ranking for the implementability criteria – as no actions are being performed. The No Action alternative is easily implemented.

7.2.1.1.7 Cost

The No Action alternative is not associated with any implementation cost and is ranked high for this criterion.

7.2.1.1.8 Overall Rating

Overall, the No Action alternative ranks low due to the lack of monitoring to confirm a reduction in concentrations and other factors, as described above.

7.2.1.2 Southern Ponds Aquatic Sediment: Alternative 2- Institutional Controls: Containment, Land Use Controls, Sediment Management, and Long-Term Operations and Management

The Institutional Controls alternative provides LUCs which limit land use and control activities in areas where the risk from one or more exposure pathways is deemed unacceptable. The LUCs would provide design criteria for development within the restricted area. An SMP would be developed to provide detailed procedures for sediment disturbing activities and describe required sampling and criteria for reuse of disturbed sediment. The LUCs and SMP would be consistent with the *Mill Site Specific Plan* (Mill Site Coordinating Committee, 2012; Figure 2-1) for future site use. Notification to DTSC and sediment removal may occur as part of future redevelopment activities and changes in use in order to achieve acceptable risk for the changed conditions. An evaluation of this alternative is provided in the following sections.

7.2.1.2.1 Overall Protection of Human Health and the Environment

The Institutional Controls alternative is anticipated to be protective of human health and the environment as it provides restrictions for access to the affected sediment and guidelines for disturbing the sediment. This alternative meets the RAOs.

7.2.1.2.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs.

7.2.1.2.3 Long-Term Effectiveness and Permanence

The Institutional Controls alternative received a moderate ranking for the long-term effectiveness criterion as the proposed LUCs and SMP would provide adequate protection of potential receptors in the long term.

7.2.1.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Institutional Controls alternative was ranked low for the reduction of toxicity, mobility, or volume through treatment criterion as no COC-impacted media would be physically removed or treated. As demonstrated in the BHHERA, COC concentrations in Southern Ponds sediment do not present significant risk to receptors and the opportunity to further reduce toxicity or risk from sediment is small.

7.2.1.2.5 Short-Term Effectiveness

The Institutional Controls alternative received a high ranking for the short-term effectiveness criteria, as it does not consider exposing construction workers to COC-impacted media as sediment is left in place.

7.2.1.2.6 Implementability

The Institutional Controls alternative received a high ranking for the implementability criteria, as it is easily implementable.

7.2.1.2.7 Cost

The Institutional Controls alternative ranked high, as the cost is comparatively lower than other process options. Costs include documentation of institutional controls, annual inspection, and periodic maintenance of established controls such as fencing.

7.2.1.2.8 Overall Rating

Overall, the Institutional Controls alternative ranks high. Although it is ranked low for the reduction of toxicity, mobility and volume criterion, institutional controls provide adequate elimination of potential exposure pathways for future receptors. Additionally, long-term effectiveness ranks moderate.

7.2.1.3 Southern Ponds Aquatic Sediment: Alternative 3 – Vegetated Soil Cover and Institutional Controls (Containment, Land Use Controls, Sediment Management, and Long-Term Operations and Maintenance)

The Vegetated Soil Cover alternative proposes to provide an upland vegetated cover to cover each individual pond (a total treatment area of approximately 122,000 sf) to restrict exposure of potential receptors to affected media and would limit potential direct contact with affected sediment or infiltration of water. The vegetated cover would consist of a surface barrier of soil that would fill each pond from the existing sediment surface to the bank rim (ranging from 6 feet of soil for Pond 1 to 9 feet of soil for Ponds 3 and 4). The soil cap would be support plant life that forms extensive root systems through low-permeability soils. This alternative would be coupled with institutional controls, and would provide LUCs to prohibit development, removal of the cover, or other soil disturbing activities in the affected area. A comprehensive SMP that provides detailed procedures for sediment disturbing activities and describes required sampling and criteria for reuse of disturbed sediment would be developed. O&M activities (e.g., inspection, re-seeding, as needed partial cover repair/replacement) will be required following implementation. An evaluation of this alternative is provided in the following sections.

7.2.1.3.1 Overall Protection of Human Health and the Environment

The Vegetated Soil Cover and Institutional Controls alternative is anticipated to be protective of human health and the environment as it provides restrictions for access to the affected sediment and guidelines for disturbing the sediment. This alternative likely meets the RAOs.

7.2.1.3.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs, though may be difficult to permit within the California Coastal Zone as covers will result in the disruption and destruction of wetland habitat which would require significant mitigation that may not be possible when considering the multiple and sometimes conflicting policies of all relevant agencies.

7.2.1.3.3 Long-Term Effectiveness and Permanence

The Vegetated Soil Cover alternative received a moderate ranking for long-term effectiveness and performance, as the cover would likely have a useful life exceeding 30 years but may require O&M. The Vegetated Soil Cover alternative would also implement LUCs to restrict site use and soil disturbing activities, including those that would diminish the integrity of the cover. Long-term maintenance of an upland cover would be easier than a cover in an area that remains a wetland.

7.2.1.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Vegetated Soil Cover alternative received a low ranking for reduction of toxicity, mobility, or volume criteria. The vegetated cover does not directly reduce the toxicity or volume through treatment.

7.2.1.3.5 Short-Term Effectiveness

The Vegetated Soil Cover and Institutional Controls alternative received a high ranking for the short-term effectiveness criteria, as it does not consider exposing construction workers to COC-impacted media as sediment is left in place.

7.2.1.3.6 Implementability

The Vegetated Soil Cover and Institutional Controls alternative received a moderate ranking for the implementability criteria, as it is easily implementable with standard construction equipment and cover materials would be locally obtainable; however, required permitting and mitigation requirements would be significant. Anticipated permits required to complete this alternative include: CCC Coastal Development Permit (CDP), City of Fort Bragg Coastal Development and Grading Permits, Mendocino County Air Quality Management District (MCAQMD) Dust Control Permit, RWQCB Section 401 of the Clean Water Act Permit, USACE Section 404 of the Clean Water Act Permit, and General Permit for Discharges of Storm Water Associated with Construction Activity (Stormwater Construction General Permit). A wetland mitigation modifier of 4:1 was identified by the CCC as necessary for projects that include placement of soil fill in wetlands. Mitigation will be performed onsite.

7.2.1.3.7 Cost

The Vegetated Soil Cover and Institutional Controls alternative ranked moderate, as the cost is comparatively lower than other process options. However, the Vegetated Soil Cover alternative may require O&M activities and consequently costs are more uncertain in comparison with institutional controls. It was assumed that the initial permitting and mitigation required to construct the vegetated soil cover would include provisions for future O&M (e.g. partial annual cover repair/replacement of cover materials).

7.2.1.3.8 Overall Rating

Overall, the Vegetated Soil Cover and Institutional Controls alternative ranks low. It should provide adequate elimination of potential exposure pathways for future receptors. However, it is ranked low for the reduction of toxicity, mobility and volume criterion, and the benefits of a physical cover are offset by the effort and disruption associated with implementation and regular O&M.

7.2.1.4 Southern Ponds Aquatic Sediment: Alternative 4 - Excavation and Disposal of Sediment

The Excavation and Disposal alternative involves the excavation and offsite disposal of sediment in the Southern Ponds, which amounts to approximately 7,000 cy with excavation to a maximum depth of 2.5 feet bgs (Pond 1 and Pond 2) and 1.5 feet bgs[13] (Pond 3) in an approximate 100,000[14] sf footprint. Sediment would be excavated using conventional construction equipment and would be either temporarily stockpiled and managed to prevent dust and odors or directly loaded into truck beds. Dewatering may be necessary for some of the excavated material. Immediately after loading, the truck beds would be covered with a tarp and transported to an appropriate non-hazardous waste disposal facility. The excavation areas may be backfilled with clean imported soil or the pond depth may be allowed to increase depending on the resulting geometry and agency permit requirements. An estimated 400 truckloads would be required to transport the sediment in the pond to an appropriate non-hazardous waste disposal facility, which is estimated to generate approximately 300,000 kilograms of CO2. Excavation would continue until confirmation sampling indicates residual concentrations are below unrestricted cleanup goals. An evaluation of this alternative is provided in the following sections.

7.2.1.4.1 Overall Protection of Human Health and the Environment

Sediment would be directly removed and disposed of offsite in a permitted landfill and, therefore, human health and the environment would be protected following implementation.

7.2.1.4.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs, though may be difficult to permit within the California Coastal Zone as excavation will result in the disruption and destruction of wetland habitat which would require mitigation.

7.2.1.4.3 Long-Term Effectiveness and Permanence

O&M is not required after completion of the excavation and disposal and sediment would be removed, as confirmed by confirmation sampling and, therefore, this alternative is ranked high for long-term effectiveness and permanence. Institutional controls to restrict site access and sediment disturbance would further increase the effectiveness of this alternative in the long-term.

7.2.1.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Excavation and disposal would remove sediment, thereby reducing the volume of affected sediment and the toxicity and mobility of the COCs remaining. Overall, this alternative ranks high for this criterion. As demonstrated in the BHHERA, COC concentrations in the Southern Ponds sediments do not present significant risk to receptors; therefore, the reduction of toxicity or risk from excavated sediment is small.

[13] One sample that exceeds the human health RBTL is deeper than all other samples with exceedances. Therefore, it was assumed that a small area would be excavated deeper to 6.5 feet bgs.
[14] No samples exceed the human health RBTL in Pond 4 and, therefore, it was assumed no excavation would be required in Pond 4.

7.2.1.4.5 Short-Term Effectiveness

An estimated 400 truckloads would be required to transport the sediment in the pond to an appropriate non-hazardous waste disposal facility. Each round-trip is estimated to be 400 miles and the total sediment transport effort is estimated to generate[15] approximately 300,000 kilograms of CO2. There is a risk of upset and spill on each trip to the appropriate waste disposal facility, Construction workers would be temporarily exposed to COC-affected sediment during implementation, existing wetlands would be disrupted, and excavated soil would require transportation off-site, which can all result in short term impacts and risks and, therefore, this alternative is ranked low for short-term effectiveness.

7.2.1.4.6 Implementability

The Excavation and Disposal alternative is ranked moderate for implementability as it is readily implementable with standard construction equipment, backfilling materials would be locally obtainable, and waste likely qualifies as non-hazardous waste for reduced disposal hazards and transport; however, required permitting and mitigation requirements would be significant. Anticipated permits required to complete this alternative include: CCC CDP, City of Fort Bragg Coastal Development and Grading Permits, MCAQMD Dust Control Permit, RWQCB Section 401 of the Clean Water Act Permit, USACE Section 404 of the Clean Water Act Permit, and Stormwater Construction General Permit. Permits for limited removal of hot spots were obtained for Ponds 2 and 3 in 2017. Additional permitting would be required for this alternative. A wetland mitigation modifier of 4:1 was identified by the CCC as necessary for projects that include placement of soil fill in wetlands. Mitigation will be performed onsite.

7.2.1.4.7 Cost

Excavation and Disposal is ranked low as it is typically the most expensive process option compared to other remedial alternatives. Costs include permitting, removal, disposal, and restoration of the affected areas.

7.2.1.4.8 Overall Rating

Overall, the Excavation and Disposal alternative ranks moderate. It is ranked high for many criteria and should provide adequate elimination of potential exposure pathways for future receptors. However, the benefits of this alternative are offset by the higher cost, effort, and ecological and community disruption as compared to other alternatives evaluated.

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[15] CO2 generation estimate based on an emission factor from the Environmental Defense Fund's "The Green Freight Handbook."

7.2.1.5 Southern Ponds Aquatic Sediment: Alternative 5 – Vegetated Sediment Cover and Institutional Controls (Containment, Land Use Controls, Sediment Management, and Long-Term Operations and Maintenance)

The Vegetated Sediment Cover alternative proposes to provide a vegetated wetland cover to cover each individual pond (a total treatment area of approximately 122,000 sf) to restrict exposure of potential receptors to affected media and would limit potential direct contact with affected sediment or infiltration of water. The vegetated cover would consist of a surface barrier of approximately 2 feet of soil and plant life that support a wetland habitat and form extensive root systems through low-permeability soils. This alternative would be coupled with institutional controls, and would provide LUCs to prohibit development, removal of the cover, or other soil disturbing activities in the affected area.

A comprehensive SMP that provides detailed procedures for sediment disturbing activities and describes required sampling and criteria for reuse of disturbed sediment would be developed. O&M activities (e.g., inspection, re-seeding, as needed partial cover repair/replacement) will be required following implementation. An evaluation of this alternative is provided in the following sections.

7.2.1.5.1 Overall Protection of Human Health and the Environment

The Vegetated Sediment Cover and Institutional Controls alternative is anticipated to be protective of human health and the environment as it provides restrictions for access to the affected sediment and guidelines for disturbing the sediment. This alternative likely meets the RAOs.

7.2.1.5.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs, though may be difficult to permit within the California Coastal Zone as covers will result in the disruption and destruction of wetland habitat which would require significant mitigation that may not be possible when considering the multiple and sometimes conflicting policies of all relevant agencies.

7.2.1.5.3 Long-Term Effectiveness and Permanence

The Vegetated Sediment Cover alternative received a moderate ranking for long-term effectiveness and performance, as the cover would likely have a useful life exceeding 30 years but will likely require O&M. Stormwater flow through the Southern Ponds is highly variable based on the developed nature of the watershed, and during large storms high velocity flows may scour the cap during each wet season resulting in significant cap repair annually. The Vegetated Sediment Cover alternative would also implement LUCs to restrict site use and soil disturbing activities, including those that would diminish the integrity of the cover.

7.2.1.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Vegetated Sediment Cover alternative received a low ranking for reduction of toxicity, mobility, or volume criteria. The Vegetated Sediment Cover (wet) would be permeable and, therefore, would not mitigate water infiltration or reduce mobility. However, the COCs are not highly mobile in water and, therefore, water infiltration is not anticipated to be an issue in this alternative. The vegetated cover does not directly reduce the toxicity or volume through treatment.

7.2.1.5.5 Short-Term Effectiveness

The Vegetated Sediment Cover and Institutional Controls alternative received a high ranking for the short-term effectiveness criteria, as it does not consider exposing construction workers to COC-impacted media as sediment is left in place.

7.2.1.5.6 Implementability

The Vegetated Sediment Cover and Institutional Controls alternative received a moderate ranking for the implementability criteria, as it is easily implementable with standard construction equipment and cover materials would be locally obtainable; however, required permitting and mitigation requirements would be significant. Anticipated permits required to complete this alternative include: CCC CDP, City of Fort Bragg Coastal Development and Grading Permits, MCAQMD Dust Control Permit, RWQCB Section 401 of the Clean Water Act Permit, USACE Section 404 of the Clean Water Act Permit, and Stormwater Construction General Permit. A wetland mitigation modifier of 4:1 was identified by the CCC as necessary for projects that include placement of soil fill in wetlands. Mitigation will be performed onsite. This ranking assumes that significant future mitigation for repair or replacement of a cap in a wetland area would not be required as additional rounds of mitigation at similar ratios may not be feasible on site in the future.

7.2.1.5.7 Cost

The Vegetated Sediment Cover and Institutional Controls alternative ranked moderate, as the cost is comparatively lower than other process options. However, the Vegetated Sediment Cover alternative may require O&M activities and consequently costs are more uncertain in comparison with institutional controls. It was assumed that the initial permitting and mitigation required to construct the vegetated soil cover would include provisions for future O&M (e.g. partial annual cover repair/replacement, annual inspection, and periodic maintenance of established controls such as fencing).

7.2.1.5.8 Overall Rating

Overall, the Vegetated Sediment Cover and Institutional Controls alternative ranks low. It should provide adequate elimination of potential exposure pathways for future receptors. However, it is ranked low for the reduction of toxicity, mobility and volume criterion, and the benefits of a physical cover are offset by the effort and disruption associated with implementation and regular O&M.

7.2.2 Selection of Preferred Alternative – Southern Ponds AOC

The Institutional Controls alternative is the preferred alternative for the Southern Ponds AOC. Although it is associated with a slightly lower reduction of toxicity, mobility and volume, institutional controls would provide adequate elimination of potential exposure pathways for future receptors. The benefits of a physical cover are offset by the effort and disruption required for implementation and potentially regular O&M. The benefits of Excavation and Disposal are offset by the effort and disruption required for implementation and the need to transport and dispose the sediment at a landfill. The cost difference between the alternatives is not justified by any significant benefits of the Vegetated Soil Cover or Excavation and Disposal alternatives.

7.3 Pond 7 Aquatic Sediment

Remedial technologies for this AOC were preliminarily screened in Section 5.1 and summarized on Table 5-2. This section presents an evaluation of the selected alternatives for the Pond 7 AOC based on the screening criteria presented in Section 6.

7.3.1 Development and Evaluation of Remedial Alternatives

7.3.1.1 Pond 7 Aquatic Sediment: Alternative 1 - No Action

The No Action alternative is intended to serve as a baseline which to compare the risk reduction effectiveness of potential technologies, as required by USEPA and NCP regulations (USEPA, 1988). In this baseline, no remedial efforts would be performed. No efforts would be undertaken to contain, remove, or monitor any areas with impacted aquatic sediment at the site. The site would be maintained by Georgia-Pacific in its current condition for the foreseeable future. An evaluation of this alternative is provided in the following sections. The existing beach berm west of Pond 7 would provide sediment containment.

7.3.1.1.1 Overall Protection of Human Health and the Environment

The No Action alternative was retained per requirement of the NCP for baseline comparison and does not meet the threshold criteria. Although natural biodegradation would likely occur, no actions would be taken to monitor or confirm attenuation. Degradation may not occur within a reasonable timeframe, and thus the RAOs for unrestricted use are not met.

7.3.1.1.2 Compliance with ARARs

ARARs would not be met for the No Action alternative.

7.3.1.1.3 Long-Term Effectiveness and Permanence

As described in Section 7.3.1.1.1, the degradation rate is unknown and would not be monitored, and, therefore, the RAOs for unrestricted use are not met. The existing beach berm west of Pond 7 would provide sediment containment. This alternative ranks low for long-term effectiveness and permanence.

7.3.1.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Although natural biodegradation would likely occur, no actions would be taken to monitor, and degradation may not occur within a reasonable timeframe, and thus no reduction of toxicity, mobility, or volume could be confirmed to justify potential long-term effectiveness. The No Action alternative ranks low for reduction of toxicity, mobility, or volume criteria.

7.3.1.1.5 Short-Term Effectiveness

The No Action alternative received a high ranking for the short-term effectiveness criteria – as no actions are being performed. Because no actions are being performed, the No Action alternative provides no additional short-term risks during implementation.

7.3.1.1.6 Implementability

The No Action alternative received a high ranking for the implementability criteria – as no actions are being performed. The No Action alternative is easily implemented.

7.3.1.1.7 Cost

The No Action alternative is not associated with any implementation cost and is ranked high for this criterion.

7.3.1.1.8 Overall Rating

Overall, the No Action alternative ranks low due to the lack of monitoring to confirm a reduction in concentrations, lack of O&M of the beach berm, and other factors, as described above.

7.3.1.2 Pond 7 Aquatic Sediment: Alternative 2- Institutional Controls: Containment, Land Use Controls, Sediment Management, and Long-Term Operations and Maintenance

The Institutional Controls alternative evaluates the risk associated with affected sediment and provides LUCs for future site use which limit land use and control activities in areas where the risk from one or more exposure pathways is deemed unacceptable. The LUCs would provide design criteria for development within the restricted area. A comprehensive SMP would provide detailed procedures for sediment disturbing activities and describe required sampling and criteria for reuse of disturbed sediment.

The LUCs and SMP would be consistent with the *Mill Site Specific Plan* (Mill Site Coordinating Committee, 2012; Figure 2-1) for future site use. Notification to DTSC and sediment removal may occur as part of future redevelopment activities and changes in use in order to achieve acceptable risk for the changed conditions. In addition, the existing beach berm west of Pond 7 would provide sediment containment. Ongoing O&M of the beach berm would be required for this alternative. An evaluation of this alternative is provided in the following sections.

7.3.1.2.1 Overall Protection of Human Health and the Environment

The Institutional Controls alternative is anticipated to be protective of human health and the environment as it provides restrictions for access to the affected sediment and guidelines for disturbing the sediment. This alternative meets the RAOs.

7.3.1.2.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs.

7.3.1.2.3 Long-Term Effectiveness and Permanence

The Institutional Controls alternative received a moderate ranking for the long-term effectiveness criterion as the proposed LUCs and SMP would provide adequate protection of potential receptors in the long term. The beach berm would be inspected annually, and maintenance would be completed, as needed. Modification of the beach berm would be restricted by institutional controls; if structure use changed, the features may be altered and additional remediation may be required.

7.3.1.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Institutional Controls alternative was ranked low for the reduction of toxicity, mobility, or volume through treatment criterion as no COC-impacted media would be physically removed or treated. As demonstrated in the BHHERA, COC concentrations in Pond 7 sediment do not present significant risk to receptors and the opportunity to further reduce toxicity or risk from sediment is small.

7.3.1.2.5 Short-Term Effectiveness

The Institutional Controls alternative received a high ranking for the short-term effectiveness criteria, as it does not consider exposing construction workers to COC-impacted media as sediment is left in place.

7.3.1.2.6 Implementability

The Institutional Controls alternative received a high ranking for the implementability criteria, as it is easily implementable. However, permits will likely be required to complete O&M as needed at the beach berm, including CCC CDP and City of Fort Bragg Coastal Development Permits.

7.3.1.2.7 Cost

The Institutional Controls alternative ranked high, as the cost is comparatively lower than other process options. Costs include documentation of institutional controls, annual inspection, and periodic maintenance of established controls such as fencing and routine maintenance and vegetation control on the beach berm.

7.3.1.2.8 Overall Rating

Overall, the Institutional Controls alternative ranks high. Although it is ranked low for the reduction of toxicity, mobility and volume criterion, institutional controls provide adequate elimination of potential exposure pathways for future receptors. Additionally, long-term effectiveness ranks moderate. The beach berm would be inspected annually and maintenance would be completed, as needed, and modification of the beach berm would be restricted by institutional controls.

7.3.1.3 Pond 7 Aquatic Sediment: Alternative 3 – Vegetated Soil Cover and Institutional Controls (Containment, Land Use Controls, Sediment Management, and Long-Term Operations and Maintenance)

The Vegetated Soil Cover alternative proposes to provide an upland vegetated cover to cover the pond (a total treatment area of approximately 4,000 sf) to restrict exposure of potential receptors to affected media and would limit potential direct contact with affected sediment or infiltration of water. The vegetated cover would consist of a surface barrier of soil that would fill each pond from the existing sediment surface to the bank rim (approximately 11 feet thick). The soil cap would support plant life that forms extensive root systems through low-permeability soils. In addition, the existing beach berm west of Pond 7 would provide sediment containment. This alternative would be coupled with institutional controls, and would provide LUCs to prohibit development, removal of the cover, or other soil disturbing activities in the affected area. A comprehensive SMP that provides detailed procedures for sediment disturbing activities and describes required sampling and criteria for reuse of disturbed sediment would be developed.

O&M activities (e.g., inspection, re-seeding, as needed partial cover repair/replacement) will be required following implementation, including regular inspection and maintenance of the beach berm. An evaluation of this alternative is provided in the following sections.

7.3.1.3.1 Overall Protection of Human Health and the Environment

The Vegetated Soil Cover and Institutional Controls alternative is anticipated to be protective of human health and the environment as it provides restrictions for access to the affected sediment and guidelines for disturbing the sediment. This alternative likely meets the RAOs.

7.3.1.3.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs, though may be difficult to permit within the California Coastal Zone as covers will result in the disruption and destruction of wetland habitat which would require significant mitigation that may not be possible when considering the multiple and sometimes conflicting policies of all relevant agencies.

7.3.1.3.3 Long-Term Effectiveness and Permanence

The Vegetated Soil Cover alternative received a moderate ranking for long-term effectiveness and performance, as the cover would likely have a useful life exceeding 30 years but may require O&M. The beach berm would be inspected annually and maintenance would be completed, as needed. Modification of the structure would be restricted by institutional controls; if the structure use changed, the feature may be altered and additional remediation may be required. The Vegetated Soil Cover alternative would also implement LUCs to restrict site use and soil disturbing activities, including those that would diminish the integrity of the cover.

7.3.1.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Vegetated Soil Cover alternative received a low ranking for reduction of toxicity, mobility, or volume criteria. The vegetated cover does not directly reduce the toxicity or volume through treatment.

7.3.1.3.5 Short-Term Effectiveness

The Vegetated Soil Cover and Institutional Controls alternative received a high ranking for the short-term effectiveness criteria, as it does not consider exposing construction workers to COC-impacted media as sediment is left in place.

7.3.1.3.6 Implementability

The Vegetated Soil Cover and Institutional Controls alternative received a moderate ranking for the implementability criteria, as it is easily implementable with standard construction equipment and cover materials would be locally obtainable; however, required permitting and mitigation requirements would be significant. Anticipated permits required to complete this alternative include: CCC CDP, City of Fort Bragg Coastal Development and Grading Permits, MCAQMD Dust Control Permit, RWQCB Section 401 of the Clean Water Act Permit, USACE Section 404 of the Clean Water Act Permit, and Stormwater Construction General Permit. A wetland mitigation modifier of 4:1 was identified by the CCC as necessary for projects that include placement of soil fill in wetlands. Mitigation will be performed onsite. This ranking assumes that significant future mitigation for repair or replacement would not be required as additional rounds of mitigation at similar ratios may not be feasible on site in the future. Additionally, a wetland establishment area was recently created in 2017 that was designed to be hydrologically connected to Pond 7 and, therefore, removing Pond 7 from the system is not ideal and may be difficult to implement.

7.3.1.3.7 Cost

The Vegetated Soil Cover and Institutional Controls alternative ranked moderate, as the cost is comparatively lower than other process options. However, the Vegetated Soil Cover alternative may require O&M activities and consequently costs are more uncertain in comparison with institutional controls. It was assumed that the initial permitting required to construct the vegetated soil cover would include provisions for future O&M (e.g. inspection, re-seeding, as needed partial repair/replacement of cover materials, and inspection, maintenance, and vegetation control on the beach berm).

7.3.1.3.8 Overall Rating

Overall, the Vegetated Soil Cover and Institutional Controls alternative ranks low. It should provide adequate elimination of potential exposure pathways for future receptors. However, it is ranked low for the reduction of toxicity, mobility and volume criterion, and the benefits of a physical cover are offset by the effort and disruption associated with implementation and regular O&M, as well as the disturbance of the newly-created wetland establishment area. The beach berm would be inspected annually and maintenance would be completed, as needed. Modification of the structure would be restricted by institutional controls.

7.3.1.4 Pond 7 Aquatic Sediment: Alternative 4 - Excavation and Disposal of Sediment

The Excavation and Disposal alternative involves the excavation and offsite disposal of the sediment in Pond 7, which amounts to approximately 900 cy[16] with excavation to a maximum depth of 14 feet bgs in an approximate 2,000 sf footprint and a 5-foot strip along 180 feet of the south wall. All Pond 7 sediment was excavated in 2017 and, therefore, additional excavation would be proposed as a step-out excavation (i.e., excavate an additional 5 feet of sediment and/or soil outside the Pond 7 border). Based on a 5-foot step-out from sections of the existing pond perimeter where previous confirmation sample results exceed unrestricted cleanup goals, an estimated additional 900 cubic yards (CY) of sediment would be excavated in this alternative. Because the southern extent of Pond 7 directly abuts the Mill Pond Dam, additional excavation along the south wall of the pond is not possible because it would disturb the Mill Pond Dam. In addition, the south wall of Pond 7 is inaccessible to conventional construction equipment due to the steep slope of the Mill Pond Dam and the distance across the pond from the north side. Sediment would be excavated using specialized construction equipment and would be either temporarily stockpiled and managed to prevent dust and odors or directly loaded into truck beds. Immediately after loading, the truck beds would be covered with a tarp and transported to an appropriate non-hazardous waste disposal facility. The excavation areas may be backfilled with clean imported soil or the pond depth may be allowed to increase depending on the resulting geometry and agency permit requirements. An estimated 50 truckloads would be required to transport the sediment in the pond to an appropriate non-hazardous waste disposal facility, which is estimated to generate approximately 40,000 kilograms of CO_2. Excavation would continue until confirmation sampling indicates residual concentrations are below unrestricted cleanup goals. An evaluation of this alternative is provided in the following sections.

7.3.1.4.1 Overall Protection of Human Health and the Environment

Sediment would be directly removed and disposed of offsite in a permitted landfill and, therefore, human health and the environment would be protected following implementation.

7.3.1.4.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs, though may be difficult to permit within the California Coastal Zone as excavation will result in the disruption and destruction of wetland habitat which would require significant mitigation that may not be possible when considering the multiple and sometimes conflicting policies of all relevant agencies. Excavation of the dam material may be prohibited by California Department of Water Resources, Division of Safety of Dams (DSOD).

7.3.1.4.3 Long-Term Effectiveness and Permanence

O&M is not required after completion of the excavation and disposal and sediment would be removed, as confirmed by confirmation sampling and, therefore, this alternative is ranked high for long-term effectiveness and permanence. Institutional controls to restrict site access and sediment disturbance would further increase the effectiveness of this alternative in the long-term.

[16] Based on recent experience at Pond 7, there is much more water than sediment. The excavation estimate was adjusted to account for the volume of water resting on top of the sediment to be excavated.

7.3.1.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Excavation and disposal would remove sediment, thereby reducing the volume of affected sediment and the toxicity and mobility of the COCs remaining. Overall, this alternative ranks high for this criterion. As demonstrated in the BHHERA, COC concentrations in the Pond 7 sediments do not present significant risk to receptors; therefore, the reduction of toxicity or risk from excavated sediment is small.

7.3.1.4.5 Short-Term Effectiveness

An estimated 50 truckloads would be required to transport the sediment in the pond to an appropriate non-hazardous waste disposal facility. Each round-trip is estimated to be 400 miles and the total sediment transport effort is estimated to generate[17] approximately 40,000 kilograms of CO2. There is a risk of upset and spill on each trip to the appropriate waste disposal facility, Construction workers would be temporarily exposed to COC-affected sediment during implementation, existing wetlands would be disrupted, and excavated soil would require transportation off-site, which can all result in short term impacts and risks and, therefore, this alternative is ranked low for short-term effectiveness.

7.3.1.4.6 Implementability

The Excavation and Disposal alternative is ranked moderate for implementability as it is readily implementable with standard construction equipment, backfilling materials would be locally obtainable, and waste likely qualifies as non-hazardous waste for reduced disposal hazards and transport; however, required permitting and mitigation requirements would be significant. Anticipated permits required to complete this alternative include: CCC CDP, City of Fort Bragg Coastal Development and Grading Permits, MCAQMD Dust Control Permit, RWQCB Section 401 of the Clean Water Act Permit, USACE Section 404 of the Clean Water Act Permit, and Stormwater Construction General Permit. A wetland mitigation modifier of 4:1 identified by the CCC as necessary for projects that include placement of soil fill in wetlands. Mitigation will be performed onsite.

Additionally, a wetland establishment area was recently created in 2017 that was designed to be hydrologically connected to Pond 7 and, therefore, completing additional work at Pond 7 would be difficult. Further, locations where previous confirmation sample results exceed unrestricted cleanup goals are along the south wall of Pond 7. Based on the geometry of the area, backfill and compaction of material to replace material removed from the dam would be infeasible.

7.3.1.4.7 Cost

Excavation and Disposal is ranked low as it is typically the most expensive process option compared to other remedial alternatives. Costs include permitting, removal, disposal, and restoration of the affected areas.

[17] CO2 generation estimate based on an emission factor from the Environmental Defense Fund's "The Green Freight Handbook."

7.3.1.4.8 Overall Rating

Overall, the Excavation and Disposal alternative ranks moderate. It is ranked high for many criteria and should provide adequate elimination of potential exposure pathways for future receptors. However, the benefits of this alternative are offset by the higher cost, effort, and ecological and community disruption as compared to other alternatives evaluated.

7.3.1.5 Pond 7 Aquatic Sediment: Alternative 5 – Vegetated Sediment Cover and Institutional Controls (Containment, Land Use Controls, Sediment Management, and Long-Term Operations and Maintenance)

The Vegetated Sediment Cover alternative proposes to provide a vegetated wetland cover to cover the pond (a total treatment area of approximately 5,000 sf) to restrict exposure of potential receptors to affected media and would limit potential direct contact with affected sediment or infiltration of water. The vegetated cover would consist of a surface barrier of approximately 2 feet of soil and plant life that support a wetland habitat and form extensive root systems through low-permeability soils. This alternative would be coupled with institutional controls, and would provide LUCs to prohibit development, removal of the cover, or other soil disturbing activities in the affected area. A comprehensive SMP that provides detailed procedures for sediment disturbing activities and describes required sampling and criteria for reuse of disturbed sediment would be developed. In addition, the existing beach berm west of Pond 7 would provide sediment containment.

O&M activities (e.g., inspection, re-seeding, as needed partial cover repair/replacement) will be required following implementation, including regular inspection and maintenance of the beach berm. An evaluation of this alternative is provided in the following sections.

7.3.1.5.1 Overall Protection of Human Health and the Environment

The Vegetated Sediment Cover and Institutional Controls alternative is anticipated to be protective of human health and the environment as it provides restrictions for access to the affected sediment and guidelines for disturbing the sediment. This alternative likely meets the RAOs.

7.3.1.5.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs, though may be difficult to permit within the California Coastal Zone as covers will result in the disruption and destruction of wetland habitat which would require significant mitigation that may not be possible when considering the multiple and sometimes conflicting policies of all relevant agencies.

7.3.1.5.3 Long-Term Effectiveness and Permanence

The Vegetated Sediment Cover alternative received a moderate ranking for long-term effectiveness and performance, as the cover would likely have a useful life exceeding 30 years but will likely require O&M. The beach berm would be inspected annually and maintenance would be completed, as needed. Modification of the structure would be restricted by institutional controls; if the structure use changed, the feature may be altered and additional remediation may be required. Stormwater flow through the Pond 7 is highly variable based on the developed nature of the watershed, and during large storms high velocity flows may scour the cap during each wet season resulting in significant cap repair annually. The Vegetated Sediment Cover alternative would also implement LUCs to restrict site use and soil disturbing activities, including those that would diminish the integrity of the cover.

7.3.1.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Vegetated Sediment Cover alternative received a low ranking for reduction of toxicity, mobility, or volume criteria. The Vegetated Sediment Cover (wet) would be permeable and, therefore, would not mitigate water infiltration or reduce mobility. However, the COCs are not highly mobile in water and, therefore, water infiltration is not anticipated to be an issue in this alternative. The vegetated cover does not directly reduce the toxicity or volume through treatment.

7.3.1.5.5 Short-Term Effectiveness

The Vegetated Sediment Cover and Institutional Controls alternative received a high ranking for the short-term effectiveness criteria, as it does not consider exposing construction workers to COC-impacted media as sediment is left in place.

7.3.1.5.6 Implementability

The Vegetated Sediment Cover and Institutional Controls alternative received a moderate ranking for the implementability criteria, as it is easily implementable with standard construction equipment and cover materials would be locally obtainable; however, required permitting and mitigation requirements would be significant. Anticipated permits required to complete this alternative include: CCC CDP, City of Fort Bragg Coastal Development and Grading Permits, MCAQMD Dust Control Permit, RWQCB Section 401 of the Clean Water Act Permit, USACE Section 404 of the Clean Water Act Permit, and Stormwater Construction General Permit. A wetland mitigation modifier of 4:1 was assumed for cost estimation purposes. It is assumed that mitigation will be performed onsite.

Additionally, a wetland establishment area was recently created in 2017 that was designed to be hydrologically connected to Pond 7 and, therefore, completing additional work at Pond 7 would be difficult.

7.3.1.5.7 Cost

The Vegetated Sediment Cover and Institutional Controls alternative ranked moderate, as the cost is comparatively lower than other process options. However, the Vegetated Sediment Cover alternative may require O&M activities and consequently costs are more uncertain in comparison with institutional controls. It was assumed that the initial permitting and mitigation required to construct the vegetated soil cover would include provisions for future O&M (e.g. partial annual cover repair/replacement, inspection, maintenance, and vegetation control on the beach berm).

7.3.1.5.8 Overall Rating

Overall, the Vegetated Sediment Cover and Institutional Controls alternative ranks low. It should provide adequate elimination of potential exposure pathways for future receptors. However, it is ranked low for the reduction of toxicity, mobility and volume criterion, and the benefits of a physical cover are offset by the effort and disruption associated with implementation and regular O&M, as well as the disturbance of the newly-created wetland establishment area. The beach berm would be inspected annually and maintenance would be completed, as needed. Modification of the structure would be restricted by institutional controls.

7.3.2 Selection of Preferred Alternative – Pond 7 Aquatic Sediment

The Institutional Controls alternative is the preferred alternative for the Pond 7 AOC. The Institutional Controls alternative evaluates the risk associated with affected sediment and provides LUCs for future site use which limit land use and control activities in areas where the risk from one or more exposure pathways is deemed unacceptable. It would also include a comprehensive SMP which would provide detailed procedures for sediment disturbing activities and describe required sampling and criteria for reuse of disturbed sediment. In addition, ongoing O&M of the existing beach berm west of Pond 7 would provide continued sediment containment. Although it is associated with a slightly lower reduction of toxicity, mobility and volume, institutional controls would provide adequate elimination of potential exposure pathways for future receptors. The benefits of a physical cover are offset by the effort and disruption required for implementation and potentially regular O&M, as well as the disturbance of the newly-created wetland establishment area. The benefits of Excavation and Disposal are offset by the effort and disruption required for implementation and the need to transport and dispose the sediment at a landfill. The cost difference between the alternatives is not justified by any significant benefits of the Vegetated Soil Cover or Excavation and Disposal alternatives.

7.4 North Pond and Pond 6 Aquatic Sediment

Remedial technologies for this AOC were preliminarily screened in Section 5.1 and summarized on Table 5-2. This section presents an evaluation of the selected alternatives for the North Pond and Pond 6 AOC based on the screening criteria presented in Section 6.

7.4.1 Development and Evaluation of Remedial Alternatives

7.4.1.1 North Pond and Pond 6 Aquatic Sediment: Alternative 1 - No Action

The No Action alternative is intended to serve as a baseline which to compare the risk reduction effectiveness of potential technologies, as required by USEPA and NCP regulations (USEPA, 1988). In this baseline, no remedial efforts would be performed. No efforts would be undertaken to contain, remove, or monitor any areas with impacted aquatic sediment at the site. The site would be maintained by Georgia-Pacific in its current condition for the foreseeable future. An evaluation of this alternative is provided in the following sections.

7.4.1.1.1 Overall Protection of Human Health and the Environment

The No Action alternative was retained per requirement of the NCP for baseline comparison and does not meet the threshold criteria. Although natural biodegradation would likely occur, no actions would be taken to monitor or confirm attenuation. Degradation may not occur within a reasonable timeframe, and thus the RAOs for unrestricted use are not met.

7.4.1.1.2 Compliance with ARARs

ARARs would not be met for the No Action alternative.

7.4.1.1.3 Long-Term Effectiveness and Permanence

As described in Section 7.4.1.1.1, the degradation rate is unknown and would not be monitored, and, therefore, the RAOs for unrestricted use are not met. This alternative ranks low for long-term effectiveness and permanence.

7.4.1.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Although natural biodegradation would likely occur, no actions would be taken to monitor, and degradation may not occur within a reasonable timeframe, and thus no reduction of toxicity, mobility, or volume could be confirmed to justify potential long-term effectiveness. The No Action alternative ranks low for reduction of toxicity, mobility, or volume criteria.

7.4.1.1.5 Short-Term Effectiveness

The No Action alternative received a high ranking for the short-term effectiveness criteria – as no actions are being performed. Because no actions are being performed, the No Action alternative provides no additional short-term risks during implementation.

7.4.1.1.6 Implementability

The No Action alternative received a high ranking for the implementability criteria – as no actions are being performed. The No Action alternative is easily implemented.

7.4.1.1.7 Cost

The No Action alternative is not associated with any implementation cost and is ranked high for this criterion.

7.4.1.1.8 Overall Rating

Overall, the No Action alternative ranks low due to the lack of monitoring to confirm a reduction in concentrations and other factors, as described above.

7.4.1.2 North Pond and Pond 6 Aquatic Sediment: Alternative 2- Institutional Controls: Containment, Land Use Controls, Sediment Management, and Long-Term Operations and Maintenance

The Institutional Controls alternative evaluates the risk associated with affected sediment and provides LUCs for future site use which limit land use and control activities in areas where the risk from one or more exposure pathways is deemed unacceptable. The existing beach berm would provide sediment containment. Ongoing O&M of the beach berm would be required for this alternative. The LUCs would provide design criteria for development within the restricted area. A comprehensive SMP would provide detailed procedures for sediment disturbing activities and describe required sampling and criteria for reuse of disturbed sediment. The LUCs and SMP would be consistent with the *Mill Site Specific Plan* (Mill Site Coordinating Committee, 2012; Figure 2-1) for future site use. Notification to DTSC and sediment removal may occur as part of future redevelopment activities and changes in use in order to achieve acceptable risk for the changed conditions. An evaluation of this alternative is provided in the following sections.

7.4.1.2.1 Overall Protection of Human Health and the Environment

The Institutional Controls alternative is anticipated to be protective of human health and the environment as it provides restrictions for access to the affected sediment and guidelines for disturbing the sediment. This alternative meets the RAOs.

7.4.1.2.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs.

7.4.1.2.3 Long-Term Effectiveness and Permanence

The Institutional Controls alternative received a moderate ranking for the long-term effectiveness criterion as the proposed LUCs and SMP would provide adequate protection of potential receptors in the long term. The beach berm would be inspected annually, and maintenance would be completed, as needed. Modification of the beach berm would be restricted by institutional controls; if future use changes, the features may be altered and additional remediation may be required.

Additional sediment sampling will be completed as requested by DTSC. Sampling will be performed consistent with the DTSC approved (DTSC, 2019) Pond 6, North Pond, and Pond 8 Sediment Sampling Work Plan (Kennedy Jenks, 2019) prior to submittal of the OU-E RAP and used to further support the proposed remedy and DTSC decision making.

7.4.1.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Institutional Controls alternative was ranked low for the reduction of toxicity, mobility, or volume through treatment criterion as no COC-impacted media would be physically removed or treated. As demonstrated in the BHHERA, COC concentrations in North Pond and Pond 6 sediment do not present significant risk to receptors and the opportunity to further reduce toxicity or risk from sediment is small.

7.4.1.2.5 Short-Term Effectiveness

The Institutional Controls alternative received a high ranking for the short-term effectiveness criteria, as it does not consider exposing construction workers to COC-impacted media as sediment is left in place.

7.4.1.2.6 Implementability

The Institutional Controls alternative received a high ranking for the implementability criteria, as it is easily implementable.

7.4.1.2.7 Cost

The Institutional Controls alternative ranked high, as the cost is comparatively lower than other process options. Costs include documentation of institutional controls, annual inspection, and periodic maintenance of established controls such as fencing, routine maintenance, and vegetation control on the beach berm.

7.4.1.2.8 Overall Rating

Overall, the Institutional Controls alternative ranks high. Although it is ranked low for the reduction of toxicity, mobility and volume criterion, institutional controls provide adequate elimination of potential exposure pathways for future receptors. Additionally, long-term effectiveness ranks moderate. The beach berm would be inspected annually and maintenance would be completed, as needed, and modification of the structure would be restricted by institutional controls.

7.4.1.3 North Pond and Pond 6 Aquatic Sediment: Alternative 3 – Vegetated Soil Cover and Institutional Controls (Containment, Land Use Controls, Sediment Management, and Long-Term Operations and Maintenance)

The Vegetated Soil Cover alternative proposes to provide an upland vegetated cover to cover each individual pond (a total treatment area of approximately 10,000 sf) to restrict exposure of potential receptors to affected media and would limit potential direct contact with affected sediment or infiltration of water. The vegetated cover would consist of a surface barrier of soil that would fill each pond from the existing sediment surface to the bank rim (5 feet of soil for Pond 6 and 4.5 feet of soil for the North Pond). The soil cap would be support plant life that forms extensive root systems through low-permeability soils. In addition, the existing beach berm would provide sediment containment.

This alternative would be coupled with institutional controls, and would provide LUCs to prohibit development, removal of the cover, or other soil disturbing activities in the affected area.

A comprehensive SMP that provides detailed procedures for sediment disturbing activities and describes required sampling and criteria for reuse of disturbed sediment would be developed.

In addition, ongoing O&M of the existing beach berm west of Pond 7 would provide continued sediment containment. O&M activities (e.g., inspection, re-seeding, as needed partial cover repair/replacement) will be required following implementation, including regular inspection and maintenance of the beach berm. An evaluation of this alternative is provided in the following sections.

7.4.1.3.1 Overall Protection of Human Health and the Environment

The Vegetated Soil Cover and Institutional Controls alternative is anticipated to be protective of human health and the environment as it provides restrictions for access to the affected sediment and guidelines for disturbing the sediment. This alternative likely meets the RAOs.

7.4.1.3.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs, though may be difficult to permit within the California Coastal Zone as covers will result in the disruption and destruction of wetland habitat which would require significant mitigation that may not be possible when considering the multiple and sometimes conflicting policies of all relevant agencies.

7.4.1.3.3 Long-Term Effectiveness and Permanence

The Vegetated Soil Cover alternative received a moderate ranking for long-term effectiveness and performance, as the cover would likely have a useful life exceeding 30 years but may require O&M. The beach berm would be inspected annually and maintenance would be completed, as needed. Modification of the structure would be restricted by institutional controls; if the structure use changed, the feature may be altered and additional remediation may be required. The Vegetated Soil Cover alternative would also implement LUCs to restrict site use and soil disturbing activities, including those that would diminish the integrity of the cover.

Additional sediment sampling will be completed as requested by DTSC. Sampling will be performed consistent with the DTSC approved (DTSC, 2019) Pond 6, North Pond, and Pond 8

Sediment Sampling Work Plan (Kennedy Jenks, 2019) prior to submittal of the OU-E RAP and used to further support the proposed remedy and DTSC decision making.

7.4.1.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Vegetated Soil Cover alternative received a low ranking for reduction of toxicity, mobility, or volume criteria. The vegetated cover does not directly reduce the toxicity or volume through treatment.

7.4.1.3.5 Short-Term Effectiveness

The Vegetated Soil Cover and Institutional Controls alternative received a high ranking for the short-term effectiveness criteria, as it does not consider exposing construction workers to COC-impacted media as sediment is left in place.

7.4.1.3.6 Implementability

The Vegetated Soil Cover and Institutional Controls alternative received a moderate ranking for the implementability criteria, as it is easily implementable with standard construction equipment and cover materials would be locally obtainable; however, required permitting and mitigation requirements would be significant. Anticipated permits required to complete this alternative include: CCC CDP, City of Fort Bragg Coastal Development and Grading Permits, MCAQMD Dust Control Permit, RWQCB Section 401 of the Clean Water Act Permit, USACE Section 404 of the Clean Water Act Permit, and Stormwater Construction General Permit. A wetland mitigation modifier of 4:1 was identified by the CCC as necessary for projects that include placement of soil fill in wetlands. Mitigation will be performed onsite. This ranking assumes that significant future mitigation for repair or replacement would not be required as additional rounds of mitigation at similar ratios may not be feasible on site in the future.

7.4.1.3.7 Cost

The Vegetated Soil Cover and Institutional Controls alternative ranked moderate, as the cost is comparatively lower than other process options. However, the Vegetated Soil Cover alternative may require O&M activities and consequently costs are more uncertain in comparison with institutional controls. It was assumed that the initial permitting required to construct the vegetated soil cover would include provisions for future O&M (e.g. partial annual cover repair/replacement, inspection, maintenance, and vegetation control on the beach berm).

7.4.1.3.8 Overall Rating

Overall, the Vegetated Soil Cover and Institutional Controls alternative ranks low. It should provide adequate elimination of potential exposure pathways for future receptors. However, it is ranked low for the reduction of toxicity, mobility and volume criterion, and the benefits of a physical cover are offset by the effort and disruption associated with implementation and regular O&M. The beach berm would be inspected annually and maintenance would be completed, as needed. Modification of the structure would be restricted by institutional controls.

7.4.1.4 North Pond and Pond 6 Aquatic Sediment: Alternative 4 - Excavation and Disposal of Sediment

The Excavation and Disposal alternative involves the excavation and offsite disposal of sediment in the North Pond and Pond 6, which amounts to approximately 2,200 cy with excavation to a maximum depth of 6 feet bgs in an approximate 10,000 sf footprint (Figures 2-33 through 2-35). Sediment would be excavated using conventional construction equipment and would be either temporarily stockpiled and managed to prevent dust and odors or directly loaded into truck beds. Dewatering may be necessary for some of the excavated material. Immediately after loading, the truck beds would be covered with a tarp and transported to an appropriate non-hazardous waste disposal facility. An estimated 125 truckloads would be required to transport the sediment in the pond to an appropriate non-hazardous waste disposal facility, which is estimated to generate approximately 90,000 kilograms of $CO2$. The excavation areas may be backfilled with clean imported soil or the pond depth may be allowed to increase depending on the resulting geometry and agency permit requirements. Excavation would continue until confirmation sampling indicates residual concentrations are below unrestricted cleanup goals. An evaluation of this alternative is provided in the following sections.

7.4.1.4.1 Overall Protection of Human Health and the Environment

Sediment would be directly removed and disposed of offsite in a permitted landfill and, therefore, human health and the environment would be protected following implementation.

7.4.1.4.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs, though may be difficult to permit within the California Coastal Zone as covers will result in the disruption and destruction of wetland habitat which would require significant mitigation that may not be possible when considering the multiple and sometimes conflicting policies of all relevant agencies.

7.4.1.4.3 Long-Term Effectiveness and Permanence

O&M is not required after completion of the excavation and disposal and sediment would be removed, as confirmed by confirmation sampling and, therefore, this alternative is ranked high for long-term effectiveness and permanence. Institutional controls to restrict site access and sediment disturbance would further increase the effectiveness of this alternative in the long-term.

Additional sediment sampling will be completed as requested by DTSC. Sampling will be performed consistent with the DTSC approved (DTSC, 2019) Pond 6, North Pond, and Pond 8 Sediment Sampling Work Plan (Kennedy Jenks, 2019) prior to submittal of the OU-E RAP and used to further support the proposed remedy and DTSC decision making.

7.4.1.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Excavation and disposal would remove sediment, thereby reducing the volume of affected sediment and the toxicity and mobility of the COCs remaining. Overall, this alternative ranks high for this criterion. As demonstrated in the BHHERA, COC concentrations in the North Pond and Pond 6 sediments do not present significant risk to receptors; therefore, the reduction of toxicity or risk from excavated sediment is small.

7.4.1.4.5 Short-Term Effectiveness

Construction workers would be temporarily exposed to COC-affected sediment during implementation, existing wetlands would be disrupted, and excavated soil would require transportation off-site, which can all result in short term impacts and risks and, therefore, this alternative is ranked low for short-term effectiveness.

7.4.1.4.6 Implementability

The Excavation and Disposal alternative is ranked moderate for implementability as it is readily implementable with standard construction equipment, backfilling materials (if needed) would be locally obtainable, and waste likely qualifies as non-hazardous waste for reduced disposal hazards and transport; however, required permitting and mitigation requirements would be significant. Based on completed permitting and mitigation at Pond 2, Pond 3, and Pond 7, the anticipated permits required to complete this alternative include: CCC CDP, City of Fort Bragg Coastal Development and Grading Permits, MCAQMD Dust Control Permit, RWQCB Section 401 of the Clean Water Act Permit, USACE Section 404 of the Clean Water Act Permit, and Stormwater Construction General Permit. A wetland mitigation modifier of 4:1 was identified by the CCC as necessary for projects that include placement of soil fill in wetlands. Mitigation will be performed onsite. This ranking assumes that significant future mitigation for repair or replacement would not be required as additional rounds of mitigation at similar ratios may not be feasible on site in the future.

7.4.1.4.7 Cost

Excavation and Disposal is ranked low as it is typically the most expensive process option compared to other remedial alternatives. Costs include permitting, removal, disposal, and restoration of the affected areas.

7.4.1.4.8 Overall Rating

Overall, the Excavation and Disposal alternative ranks moderate. It is ranked high for many criteria and should provide adequate elimination of potential exposure pathways for future receptors. However, the benefits of this alternative are offset by the higher cost, effort, and ecological and community disruption as compared to other alternatives evaluated.

7.4.1.5 North Pond and Pond 6 Aquatic Sediment: Alternative 5 – Vegetated Sediment Cover and Institutional Controls (Containment, Land Use Controls, Sediment Management, and Long-Term Operations and Maintenance)

The Vegetated Sediment Cover alternative proposes to provide a vegetated wetland cover to cover each individual pond (a total treatment area of approximately 10,000 sf) to restrict exposure of potential receptors to affected media and would limit potential direct contact with affected sediment or infiltration of water. The vegetated cover would consist of a surface barrier of approximately 2 feet of soil and plant life that support a wetland habitat and form extensive root systems through low-permeability soils. This alternative would be coupled with institutional controls, and would provide LUCs to prohibit development, removal of the cover, or other soil disturbing activities in the affected area.

A comprehensive SMP that provides detailed procedures for sediment disturbing activities and describes required sampling and criteria for reuse of disturbed sediment would be developed. In addition, the existing beach berm would provide continued sediment containment. O&M activities (e.g., inspection, re-seeding, as needed partial cover repair/replacement) will be required following implementation, including regular inspection and maintenance of the beach berm. An evaluation of this alternative is provided in the following sections.

7.4.1.5.1 Overall Protection of Human Health and the Environment

The Vegetated Sediment Cover and Institutional Controls alternative is anticipated to be protective of human health and the environment as it provides restrictions for access to the affected sediment and guidelines for disturbing the sediment. This alternative likely meets the RAOs.

7.4.1.5.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs, though may be difficult to permit within the California Coastal Zone as covers will result in the disruption and destruction of wetland habitat which would require significant mitigation that may not be possible when considering the multiple and sometimes conflicting policies of all relevant agencies.

7.4.1.5.3 Long-Term Effectiveness and Permanence

The Vegetated Sediment Cover alternative received a moderate ranking for long-term effectiveness and performance, as the cover would likely have a useful life exceeding 30 years but will likely require O&M. The beach berm would be inspected annually and maintenance would be completed, as needed. Modification of the structure would be restricted by institutional controls; if the structure use changed, the feature may be altered and additional remediation may be required. Stormwater flow through the North Pond and Pond 6 is highly variable based on the developed nature of the watershed, and during large storms high velocity flows may scour the cap during each wet season resulting in significant cap repair annually. The Vegetated Sediment Cover alternative would also implement LUCs to restrict site use and soil disturbing activities, including those that would diminish the integrity of the cover.

Additional sediment sampling will be completed as requested by DTSC. Sampling will be performed consistent with the DTSC approved (DTSC, 2019) Pond 6, North Pond, and Pond 8

Sediment Sampling Work Plan (Kennedy Jenks, 2019) prior to submittal of the OU-E RAP and used to further support the proposed remedy and DTSC decision making.

7.4.1.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Vegetated Sediment Cover alternative received a low ranking for reduction of toxicity, mobility, or volume criteria. The Vegetated Sediment Cover (wet) would be permeable and, therefore, would not mitigate water infiltration or reduce mobility. However, the COCs are not highly mobile in water and, therefore, water infiltration is not anticipated to be an issue in this alternative. The vegetated cover does not directly reduce the toxicity or volume through treatment.

7.4.1.5.5 Short-Term Effectiveness

The Vegetated Sediment Cover and Institutional Controls alternative received a high ranking for the short-term effectiveness criteria, as it does not consider exposing construction workers to COC-impacted media as sediment is left in place.

7.4.1.5.6 Implementability

The Vegetated Sediment Cover and Institutional Controls alternative received a moderate ranking for the implementability criteria, as it is easily implementable with standard construction equipment and cover materials would be locally obtainable; however, required permitting and mitigation requirements would be significant. Anticipated permits required to complete this alternative include: CCC CDP, City of Fort Bragg Coastal Development and Grading Permits, MCAQMD Dust Control Permit, RWQCB Section 401 of the Clean Water Act Permit, USACE Section 404 of the Clean Water Act Permit, and Stormwater Construction General Permit. A wetland mitigation modifier of 4:1 was identified by the CCC as necessary for projects that include placement of soil fill in wetlands. Mitigation will be performed onsite. This ranking assumes that significant future mitigation for repair or replacement would not be required as additional rounds of mitigation at similar ratios may not be feasible on site in the future.

7.4.1.5.7 Cost

The Vegetated Sediment Cover and Institutional Controls alternative ranked moderate, as the cost is comparatively lower than other process options. However, the Vegetated Sediment Cover alternative may require O&M activities and consequently costs are more uncertain in comparison with institutional controls. It was assumed that the initial permitting required to construct the vegetated soil cover would include provisions for future O&M (e.g. partial annual cover repair/replacement and inspection, maintenance, and vegetation control on the beach berm).

7.4.1.5.8 Overall Rating

Overall, the Vegetated Sediment Cover and Institutional Controls alternative ranks low. It should provide adequate elimination of potential exposure pathways for future receptors. However, it is ranked low for the reduction of toxicity, mobility and volume criterion, and the benefits of a physical cover are offset by the effort and disruption associated with implementation and regular O&M. The beach berm would be inspected annually and maintenance would be completed, as needed. Modification of the structure would be restricted by institutional controls.

7.4.2 Selection of Preferred Alternative

The Institutional Controls alternative is the preferred alternative for the North Pond and Pond 6 AOC. Although it is associated with a slightly lower reduction of toxicity, mobility and volume, institutional controls would provide adequate elimination of potential exposure pathways for future receptors. The benefits of a physical cover are offset by the effort and disruption required for implementation and potentially regular O&M. The benefits of Excavation and Disposal are offset by the effort and disruption required for implementation and the need to transport and dispose the sediment at a landfill. The cost difference between the alternatives is not justified by any significant benefits of the Vegetated Soil Cover or Excavation and Disposal alternatives.

7.5 Pond 8 Aquatic Sediment

Remedial technologies for this AOC were preliminarily screened in Section 5.1 and summarized on Table 5-2. This section presents an evaluation of the selected alternatives for the Pond 8 AOC based on the screening criteria presented in Section 6.

7.5.1 Development and Evaluation of Remedial Alternatives

7.5.1.1 Pond 8 Aquatic Sediment: Alternative 1 - No Action

The No Action alternative is intended to serve as a baseline which to compare the risk reduction effectiveness of potential technologies, as required by USEPA and NCP regulations (USEPA, 1988). In this baseline, no remedial efforts would be performed. No efforts would be undertaken to contain, remove, or monitor any areas with impacted aquatic sediment at the site. The site would be maintained by Georgia-Pacific in its current condition for the foreseeable future. An evaluation of this alternative is provided in the following sections.

7.5.1.1.1 Overall Protection of Human Health and the Environment

The No Action alternative was retained per requirement of the NCP for baseline comparison and does not meet the threshold criteria. Although natural biodegradation would likely occur, no actions would be taken to monitor or confirm attenuation. Degradation may not occur within a reasonable timeframe, and thus the RAOs for unrestricted use are not met.

7.5.1.1.2 Compliance with ARARs

ARARs would not be met for the No Action alternative.

7.5.1.1.3 Long-Term Effectiveness and Permanence

The degradation rate is unknown and would not be monitored and, therefore, the RAOs for unrestricted use are not met. This alternative ranks low for long-term effectiveness and permanence.

7.5.1.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Although natural biodegradation would likely occur, no actions would be taken to monitor, and degradation may not occur within a reasonable timeframe, and thus no reduction of toxicity, mobility, or volume could be confirmed to justify potential long-term effectiveness. The No Action alternative ranks low for reduction of toxicity, mobility, or volume criteria. As demonstrated in the BHHERA, COC concentrations in Pond 8 sediment do not present significant risk to receptors and the opportunity to further reduce toxicity or risk from sediments is small.

7.5.1.1.5 Short-Term Effectiveness

The No Action alternative received a high ranking for the short-term effectiveness criteria – as no actions are being performed. Because no actions are being performed, the No Action alternative provides no additional short-term risks during implementation.

7.5.1.1.6 Implementability

The No Action alternative received a high ranking for the implementability criteria – as no actions are being performed. The No Action alternative is easily implemented.

7.5.1.1.7 Cost

The No Action alternative is not associated with any implementation cost and is ranked high for this criteria.

7.5.1.1.8 Overall Rating

Overall, the No Action alternative ranks low due to the lack of monitoring to confirm a reduction in concentrations and other factors, as described above.

7.5.1.2 Pond 8 Aquatic Sediment: Alternative 2 - Institutional Controls (Containment, Land Use Controls, Sediment Management, and Long-Term Operations and Maintenance)

The Institutional Controls alternative provides LUCs for future site use which limit land use and control activities in areas where the risk from one or more exposure pathways is deemed unacceptable. The LUCs would provide design criteria for development within the restricted area.

To address DSOD requirements, the Mill Pond Dam would be modified to add a soil buttress at the northeast end and a rock slope protection at the crib wall near the ocean. The dam modifications would not affect existing sediment and the Mill Pond would continue to receive and treat stormwater from the site and the City of Fort Bragg. The beach berm would continue to protect the Mill Pond Dam from damage due to ocean intrusion in the lowland. This alternative would require regular inspection and maintenance of both the Mill Pond Dam and the beach berm. These features are not expected to require significant soil removal or destruction of habitat.

Concentrations of COCs in sediment in Pond 8 were shown to represent limited risk to receptors for the reasonable foreseeable use in the OU-E BHHERA. A comprehensive SMP that provides detailed procedures for sediment disturbing activities and describes required sampling and criteria for reuse of disturbed sediment would be developed. The LUCs and SMP would be consistent with future site use. Notification to DTSC and sediment removal may occur as part of future redevelopment activities and changes in use in order to achieve acceptable risk for the changed conditions. An evaluation of this alternative is provided in the following sections.

7.5.1.2.1 Overall Protection of Human Health and the Environment

The Institutional Controls alternative is anticipated to be protective of human health and the environment as it provides restrictions for access to the affected sediment and guidelines for disturbing the sediment. This alternative likely meets the RAOs.

7.5.1.2.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs.

7.5.1.2.3 Long-Term Effectiveness and Permanence

The Institutional Controls alternative received a high ranking for the long-term effectiveness criterion as the proposed LUCs and SMP would provide adequate protection of potential receptors in the long term. The design life of proposed repairs for the Mill Pond Dam is estimated to be over 100 years as the maximum credible earthquake and maximum probable flood are used for design. The need for periodic maintenance on these structures has included placement or reconfiguration of large rip rap, application of shotcrete and grout, and periodic clearing of vegetation. Major repairs have been relatively infrequent, on the order of 50 or more years between major maintenance activities.

Additional sediment sampling will be completed as requested by DTSC. Sampling will be performed consistent with the DTSC approved (DTSC, 2019) Pond 6, North Pond, and Pond 8

Sediment Sampling Work Plan (Kennedy Jenks, 2019) prior to submittal of the OU-E RAP and used to further support the proposed remedy and DTSC decision making.

7.5.1.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Institutional Controls alternative was ranked moderate for the reduction of toxicity, mobility, or volume through treatment criterion as no COC-impacted media would be physically removed or treated, but sediment containment reduces the potential mobility. As demonstrated in the BHHERA, COC concentrations in Pond 8 sediment do not present significant risk to receptors and the opportunity to further reduce toxicity or risk from sediment is small.

7.5.1.2.5 Short-Term Effectiveness

The Institutional Controls alternative received a high ranking for the short-term effectiveness criteria, as it does not consider exposing construction workers to COC-impacted media as sediment is left in place.

7.5.1.2.6 Implementability

The Institutional Controls alternative received a high ranking for the implementability criteria, as it is easily implementable.

7.5.1.2.7 Cost

The Institutional Controls alternative ranked high, as the cost is comparatively lower than other process options. Costs include documentation of institutional controls and annual inspection and periodic maintenance of established controls such as fencing, routine maintenance, and vegetation control on the beach berm as well as annual inspection, maintenance, vegetation control, and periodic survey of the Mill Pond Dam. The design life of proposed repairs for the Mill Pond Dam is estimated to be over 100 years as the maximum credible earthquake and maximum probable flood are used for design.

7.5.1.2.8 Overall Rating

Overall, the Institutional Controls alternative ranks high. Although it is ranked low for the reduction of toxicity, mobility and volume criterion, institutional controls would provide adequate elimination of potential exposure pathways for future receptors.

7.5.1.3 Pond 8 Aquatic Sediment: Alternative 3 – In-situ Soil Mixing of Sediment

The in-situ soil mixing alternative proposes to treat sediment in place through stabilization by the addition of binders and Portland cement (a total treatment volume of approximately 106,000 cy) to restrict exposure of potential receptors to affected media, and would limit potential direct contact with affected sediment, or infiltration of water. The in-situ soil mixing treatment would consist of mixing sediment with augers or excavation equipment to bind sediment within a low strength concrete material and would provide LUCs to prohibit development, damage to stabilized material, or other soil disturbing activities in the affected area. A comprehensive SMP that provides detailed procedures for sediment disturbing activities and describes required sampling and criteria for reuse of disturbed sediment would be developed. The LUCs and SMP would be consistent with future site use. In-situ soil mixing would destroy Pond 8 wetland habitat and require mitigation in the form of wetlands creation at an alternate location. Pond 8 would no longer exist after completion of this alternative.

Sediment COC concentrations would be inaccessible as a result of the treatment. An evaluation of this alternative is provided in the following sections.

7.5.1.3.1 Overall Protection of Human Health and the Environment

The in-situ soil mixing alternative is anticipated to be protective of human health and the environment as it restricts access to the affected sediment and binds COCs in a concrete-like matrix. This alternative likely meets the RAOs.

7.5.1.3.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs, though may be difficult to permit within the California Coastal Zone as in-situ soil mixing will result in the disruption and destruction of wetland habitat which may require significant mitigation that may not be possible when considering the multiple and sometimes conflicting policies of all relevant agencies. Generally, use of concrete in aquatic environments is strictly limited and at the volume necessary to treat Pond 8 sediment may result in pH excursions that would temporarily adversely affect water quality and be incompatible with some ARARs.

7.5.1.3.3 Long-Term Effectiveness and Permanence

The in-situ soil mixing alternative received a high ranking for long-term effectiveness and performance, as the treated sediment would be durable and encapsulated in a low strength concrete-like mixture that resembles stiff soil. The in-situ soil mixing alternative would also require institutional controls to restrict site use and manage activities that would disturb treated sediment.

Additional sediment sampling will be completed as requested by DTSC. Sampling will be performed consistent with the DTSC approved (DTSC, 2019) Pond 6, North Pond, and Pond 8 Sediment Sampling Work Plan (Kennedy Jenks, 2019) prior to submittal of the OU-E RAP and used to further support the proposed remedy and DTSC decision making.

7.5.1.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The in-situ soil mixing alternative received a moderate ranking for reduction of toxicity, mobility, or volume criteria. The mobility would likely be significantly reduced following implementation of the in-situ soil mixing treatment as water infiltration is mitigated and sediment is stabilized but does not directly reduce the toxicity or volume through treatment. Volume of the treated material would increase by approximately 50%. As demonstrated in the BHHERA, COC concentrations in the Pond 8 sediments do not present significant risk to receptors and the opportunity to further reduce toxicity or risk from sediment is small.

7.5.1.3.5 Short-Term Effectiveness

The in-situ soil mixing alternative received a low ranking for the short-term effectiveness criteria, as it involves disturbance of sediment exposing construction workers to COC-impacted media during treatment. The addition of the large volume of Portland cement needed to perform in-situ soil mixing could temporarily affect geochemistry in the immediate vicinity of the treatment area due to the high pH associated with the cement addition. High pH conditions are unlikely to affect dioxin but may temporarily reduce the mobility of metals in the short-term.

7.5.1.3.6 Implementability

The in-situ soil mixing alternative received a low ranking for the implementability criteria, as it would require the destruction of 280,000 sf of existing wetland. Since Pond 8 would no longer exist, stormwater flow through Pond 8 would need to be rerouted. Stormwater studies have shown that non-point sources of COCs are present in stormwater at the site at concentrations similar to those found in Pond 8 sediment. Pond 8 provides a significant treatment benefit for stormwater. Direct discharge of stormwater to the ocean or restored streams and wetlands would require the City of Fort Bragg to provide pretreatment for stormwater. This approach is unlikely to be accepted by permitting agencies without significant mitigation. Anticipated permits required to complete this alternative include: CCC CDP, City of Fort Bragg Coastal Development and Grading Permits, MCAQMD Dust Control Permit, RWQCB Section 401 of the Clean Water Act Permit, USACE Section 404 of the Clean Water Act Permit, and Stormwater Construction General Permit. A wetland mitigation modifier of 4:1 was identified by the CCC as necessary for projects that include placement of soil fill in wetlands. Mitigation will be performed onsite. This ranking assumes that significant future mitigation for repair or replacement would not be required as additional rounds of mitigation at similar ratios may not be feasible on site in the future.

7.5.1.3.7 Cost

The in-situ soil mixing alternative ranked low, as the cost is comparatively higher than other process options.

7.5.1.3.8 Overall Rating

Overall, the in-situ soil mixing alternative ranks low. It is ranked moderate for the reduction of toxicity, mobility and volume criterion, and should provide adequate elimination of potential exposure pathways for future receptors. However, the benefits of an in-situ soil mixing are offset by the effort and disruption associated with implementation and the relatively small reduction of risk achieved. Costs include permitting, soil mixing, and wetland restoration/mitigation.

7.5.1.4 Pond 8 Aquatic Sediment: Alternative 4 – Excavation and Disposal

The Excavation and Disposal for unrestricted use alternative involves the excavation and offsite disposal of sediment in Pond 8 until confirmation sampling indicates remaining concentrations of COCs in sediment allow for unrestricted use classification. The distribution of dioxin in sediment is relatively uniform laterally and vertically throughout the 106,000 cy of sediment in the pond. Sediment would be excavated using conventional construction equipment and would be either temporarily stockpiled and managed to prevent dust and odors or directly loaded into truck beds. Dewatering and or stabilization with Portland cement may be necessary for some of the excavated material. Although stabilization of sediment was not required in the 2017 excavation at Pond 7, the volume of sediment in Pond 8 could not practically be dried in a similar way. Immediately after loading, the truck beds would be covered with a tarp and transported to an appropriate non-hazardous waste disposal facility. The excavation areas may be backfilled with clean imported soil or the pond depth may be allowed to increase depending on the resulting geometry and agency permit requirements. An estimated 5,600 truckloads would be required to transport the sediment in the pond to an appropriate non-hazardous waste disposal facility, which is estimated to generate approximately 5,000,000 kilograms of CO2. Excavation and disposal would be consistent with future site use. An evaluation of this alternative is provided in the following sections.

7.5.1.4.1 Overall Protection of Human Health and the Environment

The affected sediment would be directly removed and disposed of offsite in an accredited non-hazardous landfill and, therefore, human health and the environment would be protected following implementation.

7.5.1.4.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs, though may be difficult to permit within the California Coastal Zone as excavation and disposal will result in the disruption and destruction of wetland habitat which would require significant mitigation that may not be possible when considering the multiple and sometimes conflicting policies of all relevant agencies.

7.5.1.4.3 Long-Term Effectiveness and Permanence

O&M is not required after completion of the excavation and disposal and affected sediment would be removed, as confirmed by confirmation sampling and, therefore, this alternative is ranked high for long-term effectiveness and permanence. Removing affected sediment to allow unrestricted land use would be expected to reduce risk such that institutional controls are not necessary.

Additional sediment sampling will be completed as requested by DTSC. Sampling will be performed consistent with the DTSC approved (DTSC, 2019) Pond 6, North Pond, and Pond 8 Sediment Sampling Work Plan (Kennedy Jenks, 2019) prior to submittal of the OU-E RAP and used to further support the proposed remedy and DTSC decision making.

7.5.1.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Excavation and disposal for unrestricted use would remove affected sediment, thereby reducing the volume of affected sediment and the toxicity and mobility of the COCs remaining. Overall, this alternative ranks high for this criterion. As demonstrated in the BHHERA, COC concentrations in Pond 8 sediment do not present significant risk to receptors; therefore, the reduction in toxicity or risk from sediments is small.

7.5.1.4.5 Short-Term Effectiveness

An estimated 5,600 truckloads would be required to transport the sediment in the pond to an appropriate non-hazardous waste disposal facility. Each round-trip is estimated to be 400 miles and the total sediment transport effort is estimated to generate[18] approximately 5,000,000 kilograms of CO2. Additionally, there is a risk of upset and spill on each trip to the appropriate waste disposal facility, and Construction workers would be temporarily exposed to COC-affected sediment during implementation. Therefore, this alternative is ranked low for short-term effectiveness.

7.5.1.4.6 Implementability

The Excavation and Disposal for unrestricted use alternative is ranked moderate for implementability. It is readily implementable with standard construction equipment, backfilling materials would be locally obtainable, and waste likely qualifies as non-hazardous waste for reduced disposal hazards and transport; however, required permitting and mitigation requirements would be significant, and the depth of the excavation and likely soft sediment conditions would pose significant challenges. It is likely that not all sediment containing COCs would be able to be removed and a contingency remedy of containment and institutional controls would still be required. Anticipated permits required to complete this alternative include: CCC CDP, City of Fort Bragg Coastal Development and Grading Permits, MCAQMD Dust Control Permit, RWQCB Section 401 of the Clean Water Act Permit, USACE Section 404 of the Clean Water Act Permit, and Stormwater Construction General Permit. A wetland mitigation modifier of 4:1 was assumed for cost estimation purposes. It is assumed that mitigation will be performed onsite.

7.5.1.4.7 Cost

Excavation and disposal for unrestricted use is ranked low as it is typically more expensive than other remedial alternatives. Costs include permitting, removal, disposal, and wetland restoration/mitigation.

7.5.1.4.8 Overall Rating

Overall, the Excavation and Disposal for unrestricted use alternative ranks moderate. It is ranked high for many criteria and should provide adequate elimination of potential exposure pathways for future receptors. However, the benefits of this alternative are offset by the high cost as compared to other alternatives evaluated and the relatively small reduction of risk achieved.

[18] CO2 generation estimate based on an emission factor from the Environmental Defense Fund's "The Green Freight Handbook."

7.5.1.5 Pond 8 Aquatic Sediment: Alternative 5 – Vegetated Sediment Cover (Wet) and Institutional Controls

The Vegetated Sediment Cover (wet) alternative proposes to provide a wetland vegetated cover to cover the pond (a total treatment area of approximately 280,000 sf) to restrict exposure of potential receptors to affected media, and would limit potential direct contact with affected sediment, or infiltration of water. In this alternative, wetlands at Pond 8 would be maintained after implementation of the Vegetated Sediment Cover (wet) and would continue to receive current flows from Maple Creek and Alder Creek.

The Vegetated Sediment Cover (wet) would consist of a surface barrier of soil approximately 2 feet thick and plant life that form extensive root systems through low-permeability soils. Approximately 21,000 CY of fill would be required to construct the vegetated sediment cover (wet). Based on geotechnical testing, a sediment cover would require dewatering and compaction of the sediment to support the weight of the cover and avoid damage to the cover and sediment displacement. The addition of cover materials would significantly reduce the volume and area of the pond requiring mitigation in the form of wetland creation in an alternate location. If the underlying sediment needs to be strengthened, a wick drain system may allow sediment consolidation to provide the required stability. While portions of the pond have been filled in the past, it is unknown how sediment was addressed at those times, though it is likely that sediment was displaced as the area was filled. This alternative would be coupled with institutional controls, and would provide LUCs to prohibit development, removal of the cover, or other soil disturbing activities in the affected area. The LUCs would provide design criteria for development within the restricted area. The SMP would provide detailed procedures for sediment disturbing activities and describe required sampling and criteria for reuse of disturbed sediment.

O&M activities (e.g., inspection, repairs, re-seeding) would be required following implementation. The LUCs and SMP would be consistent with future site use.

To address DSOD requirements and maintain containment of sediment, the Mill Pond Dam would be modified to add a soil buttress at the northeast end and a rock slope protection at the crib wall near the ocean. The dam modifications would not affect existing sediment. The Mill Pond Dam spillway may also need to be adjusted to maintain hydraulic conditions similar to current conditions after construction of the Vegetated Sediment Cover (wet). The beach berm would continue to protect the Mill Pond Dam from damage due to ocean intrusion in the lowland. Regular inspection and maintenance of the both the Mill Pond Dam and beach berm is required for this alternative. An evaluation of this alternative is provided in the following sections.

7.5.1.5.1 Overall Protection of Human Health and the Environment

The Vegetated Sediment Cover (wet) and Institutional Controls alternative is anticipated to be protective of human health and the environment as it provides restrictions for access to the affected sediment and guidelines for disturbing the sediment. This alternative likely meets the RAOs.

7.5.1.5.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs, though may be difficult to permit within the California Coastal Zone as covers will result in the disruption and destruction of wetland habitat which would require significant mitigation that may not be possible when considering the multiple and sometimes conflicting policies of all relevant agencies.

7.5.1.5.3 Long-Term Effectiveness and Permanence

The Vegetated Sediment Cover (wet) alternative received a low ranking for long-term effectiveness and performance, as the cover would likely have a relatively short useful life and require significant O&M. Stormwater flow through Pond 8 is highly variable based on the developed nature of the watershed. During large storms, high velocity flows from storm drains discharge beneath the water surface near the sediment interface and would be likely to scour the cap during each wet season resulting in significant cap repair annually. Further, stormwater studies have shown non-point sources of COCs are present in stormwater at concentrations similar to those found in Pond 8 sediment. Deposition of COCs above the cap would contaminate the area above unrestricted use remedial goals. The Vegetated Sediment Cover (wet) alternative would also require institutional controls to implement LUCs to restrict site use and cap disturbing activities, including those that would diminish the integrity of the cover. The design life of proposed repairs for the Mill Pond Dam is estimated to be over 100 years as the maximum credible earthquake and maximum probable flood are used for design. The need for periodic maintenance on the Mill Pond Dam and beach berm has included placement or reconfiguration of large rip rap, application of shotcrete and grout, and periodic clearing of vegetation. Major repairs have been relatively infrequent, on the order of 50 or more years between major maintenance activities.

Additional sediment sampling will be completed as requested by DTSC. Sampling will be performed consistent with the DTSC approved (DTSC, 2019) Pond 6, North Pond, and Pond 8 Sediment Sampling Work Plan (Kennedy Jenks, 2019) prior to submittal of the OU-E RAP and used to further support the proposed remedy and DTSC decision making.

7.5.1.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Vegetated Sediment Cover (wet) alternative received a moderate ranking for reduction of toxicity, mobility, or volume criteria. The Vegetated Sediment Cover (wet) does not directly reduce the toxicity or volume through treatment. The Vegetated Sediment Cover (wet) would be permeable and, therefore, would not mitigate water infiltration or reduce mobility. However, the COCs are not highly mobile in water and, therefore, water infiltration is not anticipated to be an issue in this alternative. As demonstrated in the BHHERA, COC concentrations in the Pond 8 sediments do not present significant risk to receptors and the opportunity to further reduce toxicity or risk from sediment is small.

7.5.1.5.5 Short-Term Effectiveness

The Vegetated Soil Cover (wet) and Institutional Controls alternative received a high ranking for the short-term effectiveness criteria, as it does not consider exposing construction workers to COC-impacted media as sediment is left in place.

7.5.1.5.6 Implementability

The Vegetated Soil Cover (wet) and Institutional Controls alternative received a low ranking for the implementability criteria, as it would require the disturbance or destruction of 280,000 sf of existing wetland. The average depth of water in Pond 8 is approximately 6 inches, though deeper in some areas than others. Placement of sufficient soil to restrict access to sediments and to establish the vegetated cover would likely result in an upland habitat over most of the pond. Additionally, the Mill Pond Dam spillway may also need to be raised to maintain hydraulic conditions similar to current conditions after construction of the Vegetated Soil Cover (wet). This approach is unlikely to be accepted by DSOD or other permitting agencies without significant mitigation and additional dam modifications. Anticipated permits required to complete this alternative include: CCC CDP, City of Fort Bragg Coastal Development and Grading Permits, MCAQMD Dust Control Permit, RWQCB Section 401 of the Clean Water Act Permit, USACE Section 404 of the Clean Water Act Permit, and Stormwater Construction General Permit. A wetland mitigation modifier of 4:1 was identified by the CCC as necessary for projects that include placement of soil fill in wetlands. Mitigation will be performed onsite. This ranking assumes that significant future mitigation for repair or replacement would not be required as additional rounds of mitigation at similar ratios may not be feasible on site in the future.

7.5.1.5.7 Cost

The Vegetated Soil Cover (wet) and Institutional Controls alternative ranked low, as the cost is comparatively higher than other process options, but less than full sediment removal. Long term O&M costs are uncertain and likely to be significant. It was assumed that the initial permitting required to construct the vegetated soil cover would include provisions for future O&M (e.g. partial annual cover repair/replacement). Costs include documentation of institutional controls and annual inspection and periodic maintenance of established controls such as fencing, routine maintenance, and vegetation control on the beach berm as well as annual inspection, maintenance, vegetation control, and periodic survey of the Mill Pond Dam.

7.5.1.5.8 Overall Rating

Overall, the Vegetated Soil Cover (wet) and Institutional Controls alternative ranks moderate. It is ranked moderate for the reduction of toxicity, mobility and volume criterion, and should provide adequate elimination of potential exposure pathways for future receptors. However, the benefits of a physical cover are offset by the effort and disruption associated with implementation and potentially regular O&M and the relatively small reduction of risk achieved.

7.5.1.6 Pond 8 Aquatic Sediment: Alternative 6 – Vegetated Soil Cover (Dry)

The Vegetated Soil Cover (Dry) alternative proposes to provide a vegetated cover to cover and replace the pond (a total treatment area of approximately 280,000 sf) to restrict exposure of potential receptors to affected media, and would limit potential direct contact with affected sediment, or infiltration of water. In this alternative, Pond 8 would become dry land after implementation of the Vegetated Soil Cover (dry) and would no longer receive current flows from Maple Creek and Alder Creek.

The vegetated cover would consist of a surface barrier of soil that would fill the pond from the existing sediment surface to above the water surface (3 feet of soil) and would require diversion of water flow away from the soil cap. The soil cap would be support plant life that forms extensive root systems through low-permeability soils. Approximately 31,500 cy of fill would be required to construct the vegetated soil cover (dry). Based on geotechnical testing, a soil cover would require dewatering and compaction of the sediment to support the weight of the cover and avoid damage to the cover and sediment displacement. The addition of soil cover materials and the strengthening of underlying sediment would significantly reduce the volume and area of the pond requiring mitigation in the form of wetland creation in an alternate location. If the underlying sediment needs to be strengthened, a wick drain system may allow sediment consolidation to provide the required stability. While portions of the pond have been filled in the past, it is unknown how sediment was addressed at those times, though it is likely that sediment was displaced as the area was filled.

This alternative would be coupled with institutional controls, and would provide LUCs to prohibit development, removal of the cover, or other soil disturbing activities in the affected area. A comprehensive SMP that provides detailed procedures for sediment disturbing activities and describes required sampling and criteria for reuse of disturbed sediment would be developed.

O&M activities (e.g., inspection, repairs, re-seeding) would be required following implementation. The LUCs and SMP would be consistent with future site use. An evaluation of this alternative is provided in the following sections.

To address DSOD requirements and maintain sediment containment, the Mill Pond Dam would be modified to add a soil buttress at the northeast end and a rock slope protection at the crib wall near the ocean. The dam modifications would not affect existing sediment. The beach berm would continue to protect the Mill Pond Dam from damage due to ocean intrusion in the lowland. Regular inspection and maintenance of the both the Mill Pond Dam and the beach berm is required for this alternative.

7.5.1.6.1 Overall Protection of Human Health and the Environment

The Vegetated Soil Cover (dry) and Institutional Controls alternative is anticipated to be protective of human health and the environment as it provides restrictions for access to the affected sediment and guidelines for disturbing the sediment. This alternative likely meets the RAOs.

7.5.1.6.2 Compliance with ARARs

This alternative is in compliance with the projected ARARs, though may be difficult to permit within the California Coastal Zone as covers will result in the disruption and destruction of wetland habitat which would require significant mitigation that may not be possible when considering the multiple and sometimes conflicting policies of all relevant agencies.

7.5.1.6.3 Long-Term Effectiveness and Permanence

The Vegetated Soil Cover (dry) alternative received a moderate ranking for long-term effectiveness and performance. Stormwater flow through Pond 8 would need to be diverted if Pond 8 no longer existed. The Vegetated Soil Cover (dry) alternative would also require institutional controls to implement LUCs to restrict site use and cap disturbing activities, including those that would diminish the integrity of the cover.

The design life of proposed repairs for the Mill Pond Dam is estimated to be over 100 years as the maximum credible earthquake and maximum probable flood are used for design. The need for periodic maintenance on the Mill Pond Dam and beach berm has included placement or reconfiguration of large rip rap, application of shotcrete and grout, and periodic clearing of vegetation. Major repairs have been relatively infrequent, on the order of 50 or more years between major maintenance activities.

Additional sediment sampling will be completed as requested by DTSC. Sampling will be performed consistent with the DTSC approved (DTSC, 2019) Pond 6, North Pond, and Pond 8 Sediment Sampling Work Plan (Kennedy Jenks, 2019) prior to submittal of the OU-E RAP and used to further support the proposed remedy and DTSC decision making.

7.5.1.6.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Vegetated Soil Cover (dry) alternative received a low ranking for reduction of toxicity, mobility, or volume criteria. The Vegetated Soil Cover (dry) does not directly reduce the toxicity or volume through treatment. Though not a wetland cover, the dry Vegetated Soil Cover would not be designed to limit water infiltration as solubility of the target COCs is limited and the purpose of the cover would be to eliminate exposure through direct contact and mobilization via erosion. As demonstrated in the BHHERA, COC concentrations in the Pond 8 sediments do not present significant risk to receptors and the opportunity to further reduce toxicity or risk from sediment is small.

7.5.1.6.5 Short-Term Effectiveness

The Vegetated Soil Cover (dry) and Institutional Controls alternative received a high ranking for the short-term effectiveness criteria, as it does not consider exposing construction workers to COC-impacted media as sediment is left in place.

7.5.1.6.6 Implementability

The Vegetated Soil Cover (dry) and Institutional Controls alternative received a low ranking for the implementability criteria, as it would require the destruction of 280,000 sf of existing wetland. The average depth of water in Pond 8 is approximately 6 inches, though measured depths range from approximately 3.5 feet to 0 feet (wet sediment with no free water surface). Placement of sufficient soil to restrict access to sediments and to establish the vegetated cover (dry) would likely result in an upland habitat over most of the pond. Since Pond 8 would no longer exist, stormwater flow through Pond 8 would need to be rerouted. Stormwater studies have shown that non-point sources of COCs are present in stormwater at the site at concentrations similar to those found in Pond 8 sediment. Pond 8 provides a significant treatment benefit for stormwater. Direct discharge of storm water to the ocean or restored streams and wetlands would require the City of Fort Bragg to provide pretreatment for stormwater. This approach is unlikely to be accepted by permitting agencies without significant mitigation. Anticipated permits required to complete this alternative include: CCC CDP, City of Fort Bragg Coastal Development and Grading Permits, MCAQMD Dust Control Permit, RWQCB Section 401 of the Clean Water Act Permit, USACE Section 404 of the Clean Water Act Permit, and Stormwater Construction General Permit. A wetland mitigation modifier of 4:1 was identified by the CCC as necessary for projects that include placement of soil fill in wetlands. Mitigation will be performed onsite. This ranking assumes that significant future mitigation for repair or replacement would not be required as additional rounds of mitigation at similar ratios may not be feasible on site in the future.

7.5.1.6.7 Cost

The Vegetated Soil Cover (dry) and Institutional Controls alternative ranked low, as the cost is comparatively higher than other process options, but less than full sediment removal. Long term O&M costs are uncertain and likely to be significant. It was assumed that the initial permitting required to construct the vegetated soil cover would include provisions for future O&M (e.g. partial annual cover repair/replacement). Costs include documentation of institutional controls and annual inspection and periodic maintenance of established controls such as fencing, routine maintenance, and vegetation control on the beach berm as well as annual inspection, maintenance, vegetation control, and periodic survey of the Mill Pond Dam.

7.5.1.6.8 Overall Rating

Overall, the Vegetated Soil Cover (dry) and Institutional Controls alternative ranks low. It is ranked moderate for the reduction of toxicity, mobility and volume criterion, and should provide adequate elimination of potential exposure pathways for future receptors. However, the benefits of a physical cover are offset by the effort and disruption associated with implementation and potentially regular O&M and the relatively small reduction of risk achieved.

7.5.2 Selection of Preferred Alternative

The Institutional Controls alternative is the preferred alternative for the Pond 8 AOC as it provides adequate elimination of potential exposure pathways for future receptors without the destruction of wetlands and associated mitigation. This alternative also allows Pond 8 to continue to receive and treat stormwater from the site and the City of Fort Bragg. Although it is associated with lower reduction of toxicity, mobility, and volume, institutional controls would provide adequate elimination of potential exposure pathways for future receptors. The benefits of a physical cover are offset by the effort and disruption required for implementation and potentially regular O&M. The benefits of Excavation and Disposal are offset by the effort and disruption required for implementation and the need to transport and dispose the sediment at a landfill. The cost difference between the alternatives is not justified by any significant benefits of the Vegetated Soil Cover or Excavation and Disposal alternatives.

7.6 OU-E Groundwater

Historical and RI investigations at both the IRM and West of IRM indicated impacts to soil and groundwater, although IRMs discussed in Section 2.2.3.4 resulted in soil conditions that do not pose a risk to human health or the environment. The OU-C and OU-D RI recommended that IRM AOI and West of IRM AOI groundwater should be carried forward into the FS for fuel-related constituents (Arcadis, 2011a). No risks from groundwater were identified in the OU-E BHHERA. However, OU-E Lowlands AOI groundwater is also included in the FS due to barium detected in MW-4.1

Remedial technologies for this AOC were screened in Section 5.2, as summarized in Table 5-3. This section presents an evaluation of the selected alternatives for the OU-E Groundwater AOC based on the threshold and balanced criteria presented in Section 6.

7.6.1 Development and Evaluation of Remedial Alternatives

7.6.1.1 OU-E Groundwater: Alternative 1 - No Action

The No Action alternative is intended to serve as a baseline which to compare the risk reduction effectiveness of potential technologies, as required by USEPA and NCP regulations (USEPA, 1988). In this baseline, no remedial efforts would be performed. No efforts would be undertaken to contain, remove, or monitor any areas with impacted groundwater at the site. The site would be maintained by Georgia-Pacific in its current condition for the foreseeable future. An evaluation of this alternative is provided in the following sections.

7.6.1.1.1 Overall Protection of Human Health and the Environment

The No Action alternative was retained per requirement of the NCP for baseline comparison and does not meet the threshold criteria. Although natural biodegradation would likely occur, no actions would be taken to monitor or confirm attenuation. Degradation may not occur within a reasonable timeframe, and thus the RAOs for unrestricted use are not met.

7.6.1.1.2 Compliance with ARARs

ARARs would not be met for the No Action alternative.

7.6.1.1.3 Long-Term Effectiveness and Permanence

The degradation rate is unknown and would not be monitored and, therefore, the RAOs for unrestricted use are not met. This alternative ranks low for long-term effectiveness and permanence.

7.6.1.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Although natural biodegradation would likely occur, no actions would be taken to monitor, and degradation may not occur within a reasonable timeframe, and thus no reduction of toxicity, mobility, or volume could be confirmed to justify potential long-term effectiveness. However, reductions are expected to occur as a result of naturally occurring processes. The No Action alternative ranks moderate for reduction of toxicity, mobility, or volume criteria.

7.6.1.1.5 Short-Term Effectiveness

The No Action alternative received a high ranking for the short-term effectiveness criteria – as no invasive remedial actions are being performed. Because no actions are being performed, the No Action alternative provides no additional short-term risks during implementation.

7.6.1.1.6 Implementability

The No Action alternative received a high ranking for the implementability criteria – as no invasive remedial actions are being performed. The No Action alternative is easily implemented.

7.6.1.1.7 Cost

The No Action alternative is not associated with any implementation cost and is ranked high for this criteria.

7.6.1.1.8 Overall Rating

Overall, the No Action alternative ranks low due to the lack of monitoring to confirm a reduction in concentrations and other factors, as described above.

7.6.1.2 OU-E Groundwater: Alternative 2 – Restricted Use: Land Use Controls and Long-Term Operations and Management

The Restricted Use alternative addresses both fuel-related constituents present in groundwater in the IRM and West of IRM AOIs and barium present in OU-E Lowlands AOI groundwater. This alternative places LUCs on the AOC, prohibiting the use of groundwater to eliminate exposure to COCs. Groundwater use would be restricted until WQOs are achieved or agency approval for unrestricted use is received. Groundwater use at the site would be restricted as necessary in the vicinity of the affected areas. Note that in some areas of the site concentrations are below drinking water standards or other use criteria even though above WQOs. Use of such water may be deemed acceptable on a case by case basis. Groundwater COC concentrations would continue to decline naturally through existing biological and geochemical processes. An evaluation of this alternative is provided in the following sections.

7.6.1.2.1 Overall Protection of Human Health and the Environment

This alternative restricts the use of groundwater such that human health and the environment are protected and, therefore, meets this criterion.

7.6.1.2.2 Compliance with ARARs

ARARs would be met as restrictions would be established to be in compliance with the local, state, and federal requirements.

7.6.1.2.3 Long-Term Effectiveness and Permanence

The Restricted Use alternative received a moderate ranking for the long-term effectiveness criterion as the proposed LUCs would provide adequate protection of potential receptors in the long-term.

7.6.1.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Restricted Use alternative was ranked moderate for the reduction of toxicity, mobility, or volume through treatment criterion as no COC-impacted media would be physically removed or treated, but reductions would occur as a result of naturally occurring processes.

7.6.1.2.5 Short-Term Effectiveness

The Restricted Use alternative received a high ranking for the short-term effectiveness criteria – as no invasive remedial actions are being performed. Because no invasive remedial actions are being performed, the Restricted Use alternative provides no additional short-term risks during implementation.

7.6.1.2.6 Implementability

The Restricted Use alternative received a high ranking for the implementability criteria – as no invasive remedial actions are being performed. The Restricted Use alternative is easily implemented.

7.6.1.2.7 Cost

The Restricted Use alternative is ranked high, as the cost associated with implementing and maintaining LUCs on groundwater is relatively low.

7.6.1.2.8 Overall Rating

Overall, the Institutional Controls alternative ranks moderate. Institutional controls would provide adequate restriction of potential exposure pathways for future receptors, but rank moderate for the reduction of toxicity, mobility and volume criterion.

7.6.1.3 OU-E Groundwater: Alternative 3 - Monitored Natural Attenuation and Institutional Controls

The MNA alternative addresses both fuel-related constituents present in groundwater in the IRM and West of IRM AOIs and barium present in OU-E Lowlands AOI groundwater. This alternative monitors and documents the natural decline in COC concentrations beyond RAP submittal until further monitoring is deemed unnecessary to demonstrate achievement of RAOs in a reasonable time frame. This alternative also places LUCs on the AOC, prohibiting the use of groundwater in the vicinity of affected areas to restrict exposure to COCs. Groundwater use would be restricted until WQOs are achieved or agency approval for unrestricted use is received. Note that in some areas of the site concentrations are below drinking water standards or other use criteria even though above WQOs. Use of such water may be deemed acceptable on a case by case basis. Under this alternative, natural attenuation by existing physical, biological and geochemical processes would reduce the concentrations in groundwater within a reasonable timeframe. Monitoring would be performed to evaluate changes in COC concentrations until RAOs can be met. Performance criteria for MNA are to achieve stable or decreasing trends in COC concentrations, such that WQOs will be attained in a reasonable time frame. trend. As determined appropriate, detailed discussion of additional data collection and trend analysis for this AOC would be provided in ongoing semiannual groundwater monitoring reports. An evaluation of this alternative is provided in the following sections.

7.6.1.3.1 Overall Protection of Human Health and the Environment

The MNA alternative meets the threshold criteria as human health and the environment are protected through monitoring and restrictions.

7.6.1.3.2 Compliance with ARARs

ARARs would be met as the alternative would be designed to be in compliance with the local, state, and federal requirements.

7.6.1.3.3 Long-Term Effectiveness and Permanence

The MNA alternative received a moderate ranking for the long-term effectiveness criterion as the proposed restrictions and monitoring program would provide adequate protection of potential receptors in the long term. MNA would confirm natural attenuation and quantify long-term effectiveness via monitoring.

7.6.1.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The MNA alternative was ranked moderate for the reduction of toxicity, mobility, or volume through treatment criterion as no COC-impacted media would be actively removed or treated, but reductions would occur as a result of naturally occurring processes.

7.6.1.3.5 Short-Term Effectiveness

The MNA alternative received a high ranking for the short-term effectiveness criteria – as no invasive remedial actions are being performed. Because no invasive remedial actions are being performed, the MNA alternative provides no additional short-term risks during implementation.

7.6.1.3.6 Implementability

The MNA alternative received a high ranking for the implementability criteria – as no invasive remedial actions are being performed. The MNA alternative is easily implemented.

7.6.1.3.7 Cost

The MNA alternative was ranked high. The driving cost is associated with periodic groundwater monitoring for a 30-year period.

7.6.1.3.8 Overall Rating

Overall, the MNA alternative ranks moderate. This alternative ranks moderate for the long-term effectiveness and permanence criterion, the reduction of toxicity, mobility, or volume criterion, and high for the implementability and cost criteria.

7.6.1.4 OU-E Groundwater: Alternative 4 - Enhanced Aerobic Bioremediation, Monitored Natural Attenuation, and Institutional Controls

The Enhanced Aerobic Bioremediation alternative consists of subsurface delivery of oxygen to enhance the aerobic biological degradation of COCs. This alternative would address fuel-related constituents present in groundwater in the IRM and West of IRM AOIs, but it would be ineffective for barium present in OU-E Lowlands AOI groundwater. A calcium peroxide slurry is assumed to be the substrate of oxygen to enhance bioremediation. Destruction of COC mass in-situ would accelerate clean up by treating dissolved phase COCs and accelerating mass transfer from immobile sources to groundwater to be treated, facilitating further treatment and attenuation. The Enhanced Aerobic Bioremediation alternative assumes additional COC delineation, installation of injection wells, and two injection events (25% well coverage) followed by ten years of MNA. Additional injection events may be required for accelerated treatment. This alternative applied to petroleum hydrocarbons in the IRM/West of IRM AOIs for residual diesel fuel in groundwater. Enhanced Aerobic Bioremediation would not be an appropriate remedy for Barium detected at MW-4.1. An evaluation of this alternative is provided in the following sections.

7.6.1.4.1 Overall Protection of Human Health and the Environment

The Enhanced Aerobic Biodegradation alternative meets the threshold criteria as human health and the environment are protected through remediation.

7.6.1.4.2 Compliance with ARARs

ARARs would be met as the alternative would be designed to be in compliance with the local, state, and federal requirements.

7.6.1.4.3 Long-Term Effectiveness and Permanence

The Enhanced Aerobic Biodegradation alternative was ranked high for long-term effectiveness and permanence as treatment would likely accelerate the degradation of COCs and performance monitoring would occur. Additionally, LUCs would be implemented to eliminate potential exposure pathways to receptors until WQOs are achieved or agency approval for unrestricted use is received.

7.6.1.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Enhanced Aerobic Biodegradation, alternative was ranked high as this alternative consists of active remediation to directly reduce the toxicity, mobility, and/or volume through treatment that will be monitored to ensure accelerated biodegradation to WQOs are achieved or agency approval.

7.6.1.4.5 Short-Term Effectiveness

The Enhanced Aerobic Biodegradation alternative was ranked moderate for the short-term effectiveness criterion as this alternative has the potential to expose construction workers to COC-affected media during implementation. Treatment also generates short-term secondary water quality effects that would attenuate over time but make the water unusable for a period during and following treatment.

7.6.1.4.6 Implementability

The implementability is considered moderate as additional delineation and multiple site implementation visits would be required for this alternative, and the substances would require additional health and safety precautions to handle the substrates in bulk.

7.6.1.4.7 Cost

The Enhanced Aerobic Biodegradation alternative was ranked low as it is associated with moderate to high upfront costs for design and implementation, MNA is assumed to be required for a period of 10 years, and additional injection events may be required to accelerate the biodegradation process.

7.6.1.4.8 Overall Rating

Overall, the Enhanced Aerobic Biodegradation alternative ranks moderate. It is ranked high for many criteria and should provide adequate elimination of potential exposure pathways for future receptors. However, the benefits of this alternative are offset by the high level of effort, site disruption, and cost relative to benefits as compared to other alternatives evaluated.

7.6.1.5 OU-E Groundwater: Alternative 5 - Enhanced Anaerobic Bioremediation, Monitored Natural Attenuation, and Institutional Controls

The Enhanced Anaerobic Bioremediation alternative consists of subsurface injections of an anaerobic electron acceptor such as sulfate to enhance the anaerobic biological degradation of COCs. This alternative would address fuel-related constituents present in groundwater in the IRM and West of IRM AOIs, but it would be ineffective for barium present in OU-E Lowlands AOI groundwater. A magnesium sulfate (Epsom salt) slurry is assumed to be the substrate of the electron acceptor to enhance bioremediation. Destruction of COC mass in-situ would accelerate clean up by treating dissolved phase COCs and accelerating mass transfer from immobile sources to groundwater to be treated, facilitating further treatment and attenuation. The Enhanced Anaerobic Bioremediation alternative assumes additional COC delineation, installation of injection wells, and two injection events (25% well coverage) followed by ten years of MNA. Additional injection events may be required for accelerated treatment. This alternative applied to petroleum hydrocarbons in the IRM/West of IRM AOIs for residual diesel fuel in groundwater. Enhanced Anaerobic Bioremediation would not be an appropriate remedy for Barium detected at MW-4.1. An evaluation of this alternative is provided in the following sections.

7.6.1.5.1 Overall Protection of Human Health and the Environment

The Enhanced Anaerobic Biodegradation alternative meets the threshold criteria as human health and the environment are protected through remediation.

7.6.1.5.2 Compliance with ARARs

ARARs would be met as the alternative would be designed to be in compliance with the local, state, and federal requirements.

7.6.1.5.3 Long-Term Effectiveness and Permanence

The Enhanced Anaerobic Biodegradation alternative was ranked high for long-term effectiveness and permanence as treatment would likely accelerate the degradation of COCs and performance monitoring would occur. Additionally, LUCs would be implemented to eliminate potential exposure pathways to receptors until WQOs are achieved or agency approval for unrestricted use is received.

7.6.1.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The Enhanced Anaerobic Biodegradation alternative was ranked high as this alternative consists of active remediation to directly reduce the toxicity, mobility, and/or volume through treatment that will be monitored to ensure accelerated biodegradation to WQOs are achieved or agency approval.

7.6.1.5.5 Short-Term Effectiveness

The Enhanced Anaerobic Biodegradation alternative was ranked moderate for the short-term effectiveness criterion as this alternative has the potential to expose construction workers to COC-affected media during implementation. Treatment also generates short-term secondary water quality effects that would attenuate over time but make the water unusable for a period during and following treatment.

7.6.1.5.6 Implementability

The implementability is considered moderate as additional delineation and multiple site implementation visits would be required for this alternative, and the substances would require additional health and safety precautions to handle the substrates in bulk.

7.6.1.5.7 Cost

The Enhanced Anaerobic Biodegradation alternative was ranked low as it is associated with moderate to high upfront costs for design and implementation, MNA is assumed to be required for a period of 10 years, and additional injection events may be required to accelerate the biodegradation process.

7.6.1.5.8 Overall Rating

Overall, the Enhanced Anaerobic Biodegradation alternative ranks moderate. It is ranked high for many criteria and should provide adequate elimination of potential exposure pathways for future receptors. However, the benefits of this alternative are offset by the high level of effort, site disruption, and cost relative to benefits as compared to other alternatives evaluated.

7.6.2 Selection of Preferred Alternative

The MNA alternative is the recommended alternative for the OU-E Groundwater AOC. Although the MNA alternative is associated with a slightly lower reduction of toxicity, mobility and volume, MNA would provide adequate mitigation of potential exposure pathways for future receptors. The benefits of the active remediation alternatives are offset by the short-term effectiveness and potential implementability issues, and the cost difference is not justified by significant benefits and is associated with a degree of uncertainty.

Section 8: Summary of Recommended Alternatives

Below is a summary of AOC/AOI recommendations and key advantages of the recommended alternatives described in Section 7. These recommendations are also presented in Table 8-1. Cost estimates for the recommended alternatives are included in Appendix A.

For AOCs/AOIs with approved remedial actions, the selected alternative is listed below; these remedial actions are described further in the OU-E RAW and were implemented in 2017. For the Lowland Terrestrial AOI and the Riparian Aquatic Sediment AOI, confirmation sampling performed after the implementation of the approved remedial actions confirmed that concentrations at the excavation limits are below the not to exceed remedial goals included in the OU-E RAW and meet unrestricted land use goals. These areas have been approved by DTSC for NFA (DTSC 2018a). A summary of implementation and confirmation sample results are presented in the RACR.

Additional sediment sampling will be completed as requested by DTSC. Sampling will be performed consistent with the DTSC approved (DTSC, 2019) Pond 6, North Pond, and Pond 8 Sediment Sampling Work Plan (Kennedy Jenks, 2019) prior to submittal of the OU-E RAP and used to further support the proposed remedy and DTSC decision making.

- AOIs addressed in the OU-E RAW [Lowland Terrestrial Soil AOI, Pond 7 Aquatic Sediment AOI, Ponds 1 through 4 (Southern Ponds) Aquatic Sediment AOI, and Riparian Aquatic Sediment AOI]
    - Pond 7 Aquatic Sediment Primary COCs: arsenic, barium, dioxin TEQ
    - Ponds 1 through 4 (Southern Ponds) Aquatic Sediment Primary COCs: arsenic, dioxin TEQ.
  - Approved Alternative: Excavation and Disposal
    - Eliminates exposure pathways for potential future on and offsite receptors via direct soil physical removal of hot spots and institutional controls that limit future use and control soil disturbing activities. Provide protection of human health and the environment. Provides direct reduction of toxicity, mobility, and volume.
    - Excavation implemented in 2017.
    - LUCs are necessary as contingency remedy based on remaining conditions above unrestricted use goals.
- Pond 8, North Pond and Pond 6 Aquatic Sediment AOCs
    - Pond 8 Aquatic Sediment Primary COCs: arsenic[19], dioxin TEQ
    - North Pond and Pond 6 Aquatic Sediment Primary COCs: arsenic, dioxin TEQ.

[19] As presented in the Background Metals Report, background concentrations of arsenic in California soil range from 0.6 mg/kg to 31 mg/kg (Arcadis BBL 2007d).

- Recommended Alternative: Institutional Controls: containment, land use controls, sediment management, and long-term operations and maintenance
    - When evaluated as individual aquatic AOCs, human health risks evaluated as excess lifetime cancer risk for Southern Ponds, Pond 6, Pond 7, Pond 8, and North Pond were within the risk management range of 10^{-4} to 10^{-6} established in the NCP (40 CFR 300.430; 2014) and by CalEPA (1996), indicating risk management measures are appropriate remedies for these AOCs.
    - The ERA indicated that unacceptable ecological risk is not likely for populations of plants, benthic organisms, birds, mammals and amphibians exposed to site sediment and surface water.
    - Eliminates exposure pathways for potential future on and offsite receptors via institutional and administrative management and provides protection of human health and the environment.
    - Includes implementation of a SMP to restrict site use and soil and sediment disturbing activities.
    - Easily implementable and effective in the short term as no workers are exposure to COC-affected media during implementation.
    - Allows possible future restoration of Maple and Alder Creeks while preserving existing wetland habitats.
    - Cost effective.

- OU-E Groundwater
    - Primary COCs: fuel-related constituents, barium.
  - Recommended Alternative: Monitored Natural Attenuation
    - Demonstrates a direct reduction of toxicity, mobility, and volume over time via natural biodegradation.
    - LUCs would prohibit the use of groundwater to eliminate exposure to COCs. Groundwater use would be restricted as described in the Mill Site Specific Plan (Mill Site Coordinating Committee, 2012) until WQOs are achieved or agency approval for unrestricted use is received.
    - Easily implementable and effective in the short term as no workers are exposure to COC-affected media during implementation.
    - Cost effective.

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Tables

Table 1-1: Summary of Borings in the Vicinity of the Pond 8 Fill Area AOIs Areas

AOI / AOI Area	Associated AOI	Location ID
Pond 8 Fill Area AOI - West	Parcel 6 and 8 Coastline	HSA-6.31
Pond 8 Fill Area AOI - West	Sawmill/Sorter AOI	SS-7.2
Pond 8 Fill Area AOI - West	Sawmill/Sorter AOI	SS-7.1
Pond 8 Fill Area AOI - West	Sawmill/Sorter AOI	MW-7.1
Pond 8 Fill Area AOI - West	Planer #2 AOI	OUD-DP-011
Pond 8 Fill Area AOI - West	Planer #2 AOI	OUD-DP-008
Pond 8 Fill Area AOI - West	Planer #2 AOI	OUD-DP-010
Pond 8 Fill Area AOI - West	Planer #2 AOI	OUD-DP-009
Pond 8 Fill Area AOI - South	Planer #2 AOI	OUD-DP-012
Pond 8 Fill Area AOI - South	Planer #2 AOI	OUD-DP-069
Pond 8 Fill Area AOI - South	Planer #2 AOI	DP-6.3
Pond 8 Fill Area AOI - South	Planer #2 AOI	DP-6.2
Pond 8 Fill Area AOI - South	Planer #2 AOI	MW-6.1
Pond 8 Fill Area AOI - South	Planer #2 AOI	OUD-DP-067
Pond 8 Fill Area AOI - South	Planer #2 AOI	OUD-DP-068
Pond 8 Fill Area AOI - South	Planer #2 AOI	OUD-DP-061R
Pond 8 Fill Area AOI - South	Planer #2 AOI	MW-6.4
Pond 8 Fill Area AOI - South	Planer #2 AOI	DP-6.1
Pond 8 Fill Area AOI - South	Planer #2 AOI	DP-6.4
Pond 8 Fill Area AOI - South	Planer #2 AOI	DP-6.5
Pond 8 Fill Area AOI - South	Planer #2 AOI	OUD-DP-061
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	P4-37
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	HA-4.95
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	HA-4.101
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	HA-4.96
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	HA-4.97
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	HA-4.102
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	HA-4.103
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	HA-4.98
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	HA-4.106
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	HA-4.157
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	HA-4.100
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	HA-4.105
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	HA-4.156
Pond 8 Fill Area AOI - North	Powerhouse and Fuel Barn AOI	P4-36
Pond 8 Fill Area AOI - East	West of IRM AOI	OUC-DP-063
Pond 8 Fill Area AOI - East	West of IRM AOI	OUC-DP-064
Pond 8 Fill Area AOI - East	West of IRM AOI	MW-5.15
Pond 8 Fill Area AOI - East	West of IRM AOI	MW-5.21
Pond 8 Fill Area AOI - East	West of IRM AOI	MW-5.18
Pond 8 Fill Area AOI - East	Pond 8 Fill Area AOI	P5-PH8
Pond 8 Fill Area AOI - East	Pond 8 Fill Area AOI	HSA-5.43
Pond 8 Fill Area AOI - East	Pond 8 Fill Area AOI	DP-5.43
Pond 8 Fill Area AOI - East	West of IRM AOI	HSA-5.45
Pond 8 Fill Area AOI - East	West of IRM AOI	HSA-5.44

Table 1-1: Summary of Borings in the Vicinity of the Pond 8 Fill Area AOIs Areas

AOI / AOI Area	Associated AOI	Location ID
Pond 8 Fill Area AOI - East	West of IRM AOI	HSA-5.46
Pond 8 Fill Area AOI - East	Miscellaneous AOI	HSA-5.47
Pond 8 Fill Area AOI - East	West of IRM AOI	MW-5.14
Pond 8 Fill Area AOI - East	West of IRM AOI	MW-5.17
Pond 8 Fill Area AOI - East	Pond 8 Fill Area AOI	DP-5.42
Pond 8 Fill Area AOI - East	Pond 8 Fill Area AOI	HSA-5.42
Pond 8 Fill Area AOI - East	Pond 8 Fill Area AOI	HSA-5.41
Pond 8 Fill Area AOI - East	Miscellaneous AOI	HSA-5.48
Pond 8 Fill Area AOI - East	Miscellaneous AOI	HSA-5.40
Pond 8 Fill Area AOI - East	Miscellaneous AOI	DP-5.40
Pond 8 Fill Area AOI - East	Miscellaneous AOI	HSA-5.51
Pond 8 Fill Area AOI - East	Miscellaneous AOI	HSA-5.50
Pond 8 Fill Area AOI - East	Miscellaneous AOI	HSA-5.49
Pond 8 Fill Area AOI - East	Miscellaneous AOI	DP-5.39
Pond 8 Fill Area AOI - East	Miscellaneous AOI	DP-5.38
Pond 8 Fill Area AOI - East	Miscellaneous AOI	DP-5.37
Pond 8 Fill Area AOI - East	Sawmill #1 AOI	DP-5.56
Pond 8 Fill Area AOI - East	Sawmill #1 AOI	MW-5.7
Pond 8 Fill Area AOI - East	Sawmill #1 AOI	OUE-DP-028
Pond 8 Fill Area AOI - East	Sawmill #1 AOI	OUE-DP-029
Pond 8 Fill Area AOI - East	Sawmill #1 AOI	DP-5.55
Pond 8 Fill Area AOI - East	Sawmill #1 AOI	DP-5.54
Pond 8 Fill Area AOI - East	Sawmill #1 AOI	P5-2
Pond 8 Fill Area AOI - East	Sawmill #1 AOI	P5-1
Pond 8 Fill Area AOI - East	Miscellaneous AOI	MW-5.6
Pond 8 Fill Area AOI - East	Former Oil House AOI	OUC-DP-034
Pond 8 Fill Area AOI - East	Former Oil House AOI	OUC-DP-051
Pond 8 Fill Area AOI - East	Former Oil House AOI	DP-5.52
Pond 8 Fill Area AOI - East	Former Oil House AOI	OUC-DP-052

r	Exposure Interval (feet bgs)	Non-Cancer Hazard Index[a]	Non-Cancer Driver	Non-Cancer Comment	Excess Lifetime Cancer Risk[a, b]	Risk Driver	Risk Comment
Vorker	0-0.5	2E+00	Barium (44%) - Inh Dioxin (34%) - Soil	Individual HIs for Barium and dioxin do not exceed 1. Cumulative HI is below one when Dioxin hot spot is removed.[c]	1E-06	--	--
	0-2	5E+00	Dioxin (73%) - Soil	Dioxin HI exceeds 1. Cumulative HI is below one when Dioxin hot spot is removed.[c]	5E-06	Dioxin (91%) - Soil	Dioxin-specific ELCR exceeds 1E-06. Cumulative ELCR is less than 1E-6 when Dioxin hot spot is
	0-6	3E+00	Dioxin (63%) - Soil	Dioxin HI exceeds 1. Cumulative HI is below one when Dioxin hot spot is removed[c]	4E-06	Dioxin (77%) - Soil	Dioxin-specific ELCR exceeds 1E-06. Cumulative ELCR is less than 1E-6 when Dioxin hot spot is
	0-10	3E+00	Barium (14%) - Inh Dioxin (59%) - Soil	HI for Barium does not exceed 1. Dioxin HI exceeds 1. Cumulative HI is below one when Dioxin hot spot is removed.[c]	3E-06	Dioxin (75%) - Soil	Dioxin-specific ELCR exceeds 1E-06. Cumulative ELCR is less than 1E-6 when Dioxin hot spot is
ker	0-0.5	2E-01	--	--	8E-07	--	--
	0-2	4E-01	--	--	3E-06	Dioxin (91%) - Soil	Dioxin-specific ELCR exceeds 1E-06. Cumulative ELCR is less than 1E-6 when Dioxin hot spot is
	0-6	3E-01	--	--	2E-06	Dioxin (76%) - Soil	Dioxin-specific ELCR exceeds 1E-06. Cumulative ELCR is less than 1E-6 when Dioxin hot spot is
eational sive)	0-0.5	1E-01	--	--	2E-06	Arsenic (74%) - Soil	Dioxin-specific ELCR exceeds 1E-06. Cumulative ELCR is less than 1E-6 when Dioxin hot spot is
	0-2	5E-01	--	--	6E-06	Dioxin (93%) - Soil	Dioxin-specific ELCR exceeds 1E-06. Cumulative ELCR is less than 1E-6 when Dioxin hot spot is
eational nent)	0-0.5	1E-01	--	--	4E-06	Arsenic (30%) - Soil Dioxin (67%) - Soil	Arsenic EPC (6.62 mg/kg) is less than background (10 mg/kg). I for arsenic and dioxin do not exceed 1E-06. Cumulative ELCR is less than 1E-6 when Dioxin hot spot is
	0-2	4E-01	--	--	2E-05	Dioxin (86%) - Soil	Dioxin-specific ELCR exceeds 1E-06. Cumulative ELCR is less than 1E-6 when Dioxin hot spot is rem EPC (5.95 mg/kg) is consistent with background (10 r
Vorker	0-0.5	3E-01	--	--	1E-05	Arsenic (27%) - Soil Dioxin (71%) - Soil	Arsenic EPC (6.62 mg/kg) is less than background (10 Dioxin-specific ELCR exceeds 1E-06. Cumulative ELCR is less than 1E-6 when Dioxin hot spot is
	0-2	1E+00	--	--	4E-05	Dioxin (93%) - Soil	Dioxin-specific ELCR exceeds 1E-06. Cumulative ELCR is less than 1E-6 when Dioxin hot spot is rem EPC (5.95 mg/kg) is consistent with background (10 r
ational sive) /year)	0-0.5	1E-01	--	--	1E-06	--	--
	0-2	1E-01	--	--	1E-06	--	--
ational sive) /year	0-0.5	4E-01	--	--	5E-06	Arsenic (40%) - Sediment Dioxin (54%) - Sediment	Individual ELCRs for arsenic and dioxin exceed 1E
	0-2	5E-01	--	--	6E-06	Arsenic (31%) - Sediment Dioxin (63%) - Sediment	Individual ELCRs for arsenic and dioxin exceed 1E

or	Exposure Interval (feet bgs)	Non-Cancer Hazard Index[a]	Non-Cancer Driver	Non-Cancer Comment	Excess Lifetime Cancer Risk[a, b]	Risk Driver	Risk Comment
ational sive) /year	0-0.5	1E-01	--	--	2E-06	Arsenic (42%) - Sediment Dioxin (50%) - Sediment	Individual ELCRs for arsenic and dioxin do not exceed
	0-2	1E-01	--	--	2E-06	Arsenic (41%) - Sediment Dioxin (52%) - Sediment	Individual ELCRs for arsenic and dioxin do not exceed
ational sive) /year	0-0.5	5.E-01	--	--	8.E-06	Arsenic (42%) - Sediment Dioxin (51%) - Sediment	Individual ELCRs for arsenic and dioxin exceed 1E
	0-2	4.E-01	--	--	7.E-06	Arsenic (41%) - Sediment Dioxin (53%) - Sediment	Individual ELCRs for arsenic and dioxin exceed1E-
ational sive) /year	0-0.5	9E-02	--	--	6E-07	--	--
	0-2	9E-02	--	--	6E-07	--	--
ational sive) /year	0-0.5	2E-01	--	--	4E-06	Arsenic (60%) - Sediment Dioxin (38%) - Sediment	Arsenic-specific ELCR exceeds 1E-06. Dioxin-specific ELCR does not exceed 1E-06.
	0-2	2E-01	--	--	3E-06	Arsenic (53%) - Sediment Dioxin (44%) - Sediment	Arsenic-specific ELCR exceeds 1E-06. Dioxin-specific ELCR does not exceed 1E-06.
ational sive) /year	0-0.5	1E+00	--	--	2E-05	Arsenic (38%) - Sediment Dioxin (60%) - Sediment	Individual ELCRs for arsenic and dioxin exceed 1E
	0-2	1E+00	--	--	2E-05	Arsenic (37%) - Sediment Dioxin (62%) - Sediment	Individual ELCRs for arsenic and dioxin exceed 1E
ational sive) /year	0-0.5	3E-01	--	--	2E-06	Arsenic (36%) - Sediment Dioxin (48%) - Sediment	Arsenic EPC (12 mg/kg) is consistent with background (10 mg ELCRs for arsenic and dioxin do not exceed 1E-0
	0-2	3E-01	--	--	2E-06	Arsenic (34%) - Sediment Dioxin (45%) - Sediment	Arsenic EPC (11 mg/kg) is consistent with background (10 mg ELCRs for arsenic and dioxin do not exceed 1E-0
ational sive) /year	0-0.5	1E-02	--	--	1E-07	--	--
	0-2	1E-02	--	--	1E-07	--	--
ational sive) /year	0-0.5	5E-02	--	--	2E-06	Arsenic (96%) - Sediment	Arsenic-specific ELCR exceeds 1E-06.
	0-2	5E-02	--	--	2E-06	Arsenic (97%) - Sediment	Arsenic-specific ELCR exceeds 1E-06.
ational sive) /year	0-0.5	6E-02	--	--	8E-07	--	--
	0-10	6E-02	--	--	8E-07	--	--

, sediment, groundwater, and surface water. Refer to Appendix G for exposure doses and risk calculations
t, Operable Units C and D (OU-C/OU-D RI), Former Georgia-Pacific Wood Products Facility, Fort Bragg California. Prepared for Georgia-Pacific LLC. ARCADIS U.S., Inc. Revised February 2011.
DTSC not-to-exceed values were identified and removed from the baseline soil dataset. Resulting residual EPCs are less than the risk-based target levels developed for human receptors. Refer to Section 6.4.1.1 of the BHHERA.
Human Health and Ecological Risk Assessment (BHHERA). Arcadis. 2015b. Baseline Human Health and Ecological Risk Assessment – Operable Unit E, Former Georgia-Pacific Wood Products Facility, Fort Bragg, California. Prepared for Georgia-

E-6 or 1, respectively

HI = Hazard Index
ELCR = Excess Lifetime Cancer Risk
Inh = Dust Inhalation Pathway is driver
mg/kg = milligrams per kilogram
N/A = not applicable to terrestrial OU-E Lowland AOI

Table 2-2: Sample Identification Nomenclature

Feasibility Study Section	Investigation	Sample Identification Nomenclature	Definition
2.2.1.1	Lead-Based Paint Investigation	--	Sample identification nomenclature unknown [a]
2.2.1.2	Phase I Environmental Site Assessment	--	Samples were not collected during this assessment
2.2.1.3	Phase II Environmental Site Assessment	PX-Y	Soil sample, where P = parcel, X = parcel number, and Y = location number
		MW-X	Monitoring well, where X = monitoring well ID
		PX-TPY	Soil sample collected from a test pit, where X = parcel number and Y = location number
		PX-PHY; PX-TY	Soil sample collected from a pothole, where X = parcel number and Y = location number
		SB-X	Soil boring, where X = location number
		SPXY	Soil samples collected from the South Ponds, where X = location number and Y = secondary location number
		some misc. sample locations were named by their location (for example, "Kiln" near the former kiln location)	
2.2.1.4	2004 Additional Site Assessment	PX-Y	Soil sample, where P = parcel, X = parcel number, and Y = location number
		PX-PHY	Soil sample collected from a pothole, where X = parcel number and Y = location number
2.2.1.5	2005 Additional Site Assessment	DP-X	Direct push location, where X = location number
		GTB-X	Unknown [a]
		MW-X	Monitoring well, where X = monitoring well ID
		HSA-X	Boring completed by hollow-stem auger drill rig, where X = location number
		SD-X	Storm drain location, where X = location number
		SS-X	Unknown [a]
		AS-X	Sample collected from ash stockpile, where X = location number
2.2.1.6.1	2008 Pond 8 Sediment Investigations	Pond X-YY	Sample collected from a pond, where X = pond number and Y = two-digit location number
2.2.1.6.2	2009 Pond 8 Additional Sediment Investigation	Pond X-YY	Sample collected from a pond, where X = pond number and Y = two-digit location number
2.2.1.6.3	2012 Pond 8 Geotechnical and Chemical Investigation	XYZ; XY-Z	Sample nomenclature based on survey grid, where X and Y were grid identifiers and Z = location number
2.2.1.6.4	2013 BHHERA Investigation	DP-X	Direct push location, where X = location number
		Pond X-YY	Sample collected from a pond, where X = pond number and Y = two-digit location number
		OUX-DP-YYY	Direct push location, where X = operable unit ID and Y = three-digit location number
		OUX-HA-YYY	Hand auger location, where X = operable unit ID and Y = three-digit location number
		FL-CS-XXX	Unknown [a]
		RXX-CS-YY	Unknown [a]
		HA-X	Hand auger location, where X = location number
		PX-Y	Soil sample, where P = parcel, X = parcel number, and Y = location number
		MW-X	Monitoring well, where X = monitoring well ID
		SPXY	Soil samples collected from the South Ponds, where X = location number and Y = secondary location number
2.2.1.7	Groundwater Monitoring	MW-X-DDDD	Monitoring well, where X = monitoring well ID and DDDD is the date collected

Notes:
(a) In some cases, sample identification nomenclature was not explicitly described in the associated work plan or report text. If the report was prepared by another consultant, the definition of the sample identification nomenclature could not be confirmed.

	42 USC 7401-7642	Emission standards from stationary and mobile sources
	33 USCA 1251-1376 40 CFR 100-149	Regulations requiring development and implementation of a storm water pollution prevention plan
Preservation Action	16 USC 469 36 CFR 65	Provides requirements if significant scientific/cultural/historical artifacts are found
	29 CFR 1910.120	Establishes requirements for health and safety training
	USEPA Region 9, 2015	Risk-based concentrations that are intended to assist risk assessors and others in initial screening-l evaluations of environmental measurements
	42 USC 6901 et. seq. 40 CFR 258	Establishes criteria for generation, management, and disposal of non-hazardous solid waste
Act (RCRA)	42 USC 6901 et. seq. 40 CFR 261	Establishes criteria to determine whether solid waste exhibits characteristics that makes it a regulate hazardous waste
	42 USC 6901 et. seq. 40 CFR 263	Standards applicable to transporters of hazardous waste
nd; Ecological Risk Assessment Guidance g Levels	USEPA, 1989, 1997, 2010	Guidance and framework to assess human and ecological risks
	40 CFR 761.60, 761.61, 761.75	Regulations that determine the appropriate characterization, cleanup, and disposal requirements fo

	HSC 39000-44071 MCAQMD Regulations 1-5	Establishes standards for emissions of chemical vapors and dust
	Public Resources Code Division 20	Establishes permitting requirements and conditions for any "development" which remedial activities as.
	PRC Division 13	Mandates environmental impact review of projects approved by governmental agencies
unt Act	HSC 25300-25395.15	Establishes site mitigation and cost recovery programs
	HSC 5100-25250.26	Establishes hazardous waste control measures
ces Control Screening Levels	Department of Toxic Substances Control, Human Health Risk Assessment Note 3, DTSC-modified Screening Levels, April 2019	Modified screening levels based on the U.S. Environmental Protection Agency (USEPA) Regional S Levels (RSLs) for use in the human health risk assessment process at hazardous waste sites and p facilities
rements and Procedures	Title 18, Chapter 18.60 et. seq.	Establishes requirements for excavation and grading
n Policy	Open Space Element	Includes several policies addressing development in Environmental Sensitive Habitat Areas (ESHA) streams, riparian habitat, public access, water quality
n Policy	Safety Element	Includes several policies addressing safe development within coastal zone, including along bluff anc beaches
n Policy	Community Design Element	Includes several policies addressing design issues like views, scenic areas, alteration of landforms
equirements	27 CCR 21090(a)(1) through (3) and (b)(1)	Establishes criteria for cover and grading. Alternative cover designs are also acceptable.
d	Title 23, California Code of Regulations, Division 3, Chapter 15	Applies to discharge of waste
	MCAQMD Regulation 1 Chapters 1, 2 and 4	Establishes emission standards and permitting requirements for equipment and dust
aste	HSC 25100 et. seq. 22 CCR 66261	Establishes criteria for characterization and classification of remediation waste.
orting and Transportation of Hazardous	22 CCR Chapter 13	Governs transportation of hazardous materials
	8 CCR GISO 5192	Establishes worker health and safety requirements
ct	California Water Code, Section 13000	Establishes policy for preservation and enhancement of the beneficial uses of the waters of the stat
Conservation of Fish and Wildlife	California Fish and Game Code Section 2014	Requires conservation of natural resources and prevention of the willful or negligent destruction of b mammals, fish, reptiles, or amphibia.
	California Fish and Game Code Section 1600	Establishes protection and conservation of the fish and wildlife resources.
	EO-95-007-PP	Guidance and framework to develop a remedial action plan

us to Fish and Wildlife	California Fish and Game Code Section 5650	certain specified pollutants.
er	Docket No. HSA-RAO 06-07-150	Establishes requirements for investigation and site remediation
	22 CCR 66261.113	Establishes standards to disposal of PCBs
SWRCB) Resolution No. 68-16	SWRCB, 1968	Establishes policy for the regulation of discharges to waters of the state.
	SWRCB, 1996 California Water Code Section 13304	Establishes policies and procedures for investigation and cleanup and abatement of discharges.
ted Soil	HSC 25123.3(a)(20)	Establishes standards for stockpiling of non-RCRA contaminated soil
lth Multimedia Risk Assessments of Facilities; Guidance for Ecological Risk and Permitted Facilities	DTSC, 1996 CalEPA, 2015	Guidance and framework to assess human and ecological risks
ontrol Act of 1972	22 CCR 66260.1 et seq.	Establishes criteria for determining waste classification for the purposes of transportation and dispo wastes
	22 CCR 66262.1 et seq.	Establishes standards applicable to generators of hazardous waste
	22 CCR Chapter 18	Identifies hazardous waste restricted from land disposal unless specific treatment standards are me
e of Regulations	27 CCR 20005 et seq.	Regulation of solid waste
Coast Region	Basin Plan, June 2018	The North Coast Basin Plan is designed to provide a definitive program of actions to preserve and e water quality and protect beneficial uses of all regional waters.
aters of California (California Ocean Plan),	State Water Resources Control Board Resolutions Nos. 2012-0056; 2012-0057	Addresses degradation of marine communities or other exceedances of water quality objectives due waste discharges.
se Guidance	State of California Sea-Level Rise Guidance, 2018 Update	The Guidance provides: 1) a synthesis of the best available science on sea-level rise projections an for California; 2) a stepwise approach for state agencies and local governments to evaluate those projections and related hazard information in decision-making; and 3) preferred coastal adaptation approaches." Most current version of guidance will be considered when permit applications are pre
ral Protection	California Public Resources Code Section 21080.3.1	Requires that lead agency consult with Native American tribe that is traditionally and culturally affili the geographical area prior to release of negative declaration or environmental impact report for a p

ropriate Requirements
ection Agency

eening Levels
s Control

lity Management District

NCRWQCB - North Coast Regional Water Quality Control Board
PCB - polychlorinated biphenyl
PRC - Public Resource Code
RCRA - Resource Conservation and Recovery Act
SWRCB – State Water Resources Control Board
TBC - to be considered
USC – United States Code
USCA – United States Code Annotated
USEPA - United States Environmental Protection Agency

or Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities . State of California Environmental Protection Agency, Office of Scientific Affairs. August.
sment (HHRA) Note 3, DTSC-modified Screening Levels (DTSC-SLs). April.
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PC) and California Natural Resources Agency. 2018. State of California Sea Level Rise Guidance, 2018 Update. http://www.opc.ca.gov/webmaster/ftp/pdf/aqenda items/20180314/Item3 Exhibit-A OPC
2018. Sea Level Rise Policy Guidance. July. https://documents.coastal.ca.gov/assets/climate/2018ScienceUpdate_website_7.20.18.pdf

Table 3-2: OU-E Draft Site-Specific Cleanup Goals for Sediment, Soil, and Groundwater

COC	Media	Units	Draft Site-Specific Cleanup Goal	Basis for Goal
Arsenic	Sediment and Soil	mg/kg	10	Site-specific Background Concentrations
Dioxin TEQ [a]	Sediment and Soil	pg/g	53	Selected RBTL (Human Health RBTL) [b]
B(a)P [a]	Soil	mg/kg	0.4	Selected RBTL (Human Health RBTL) [c]
Lead [a]	Soil	mg/kg	127	Selected RBTL (Ecological RBTL) [b]
TPHd, TPHg (C10-C24)	Soil	mg/kg	10,772	Direct Contact and Indoor Air RBSC (unrestricted use)
Arsenic [d]	Groundwater [e]	µg/L	2.5	Background
Barium	Groundwater [e]	µg/L	1,000	CA Primary MCL
Total Gasoline (C6-C10)	Groundwater [e]	µg/L	50	T&O Threshold
Total Diesel (C10-C24)	Groundwater [e]	µg/L	100	T&O Threshold

Notes:
(a) The B(a)P and lead human health RBTLs, as defined in the OU-E RAW, is protective of a commercial/industrial worker receptor. The Dioxin TEQ human health RBTL, as defined in the OU-E RAW, is protective of the BHHERA occasional recreator.
(b) Human Health RBTLs and Ecological RBTLs are further described in the OU-E RAW.
(c) DTSC Advisory, *Use of the Northern and Southern California PAH Studies in the Manufactured Gas Plant Site Cleanup Process* (DTSC 2009)
(d) The drinking water MCL (for comparison) for arsenic is 10 µg/L.
(e) The draft site-specific groundwater cleanup goals are for unrestricted land use. Some alternatives presented in this Feasibility Study propose Institutional Controls to limit land use, and therefore, these draft cleanup goals may not be appropriate for all alternatives.

CA Primary MCL = California Department of Public Health Primary MCL
CVWQCB T&O = CVRWQCB (2004) TPH water quality objectives for taste and odor
MCL = Maximum Contaminant Level
T&O = taste and odor
µg/L = micrograms per liter = parts per billion
mg/kg = milligrams per kilogram = parts per million
pg/g = picograms per gram = parts per trillion

n	No remedial action	---		---		---		Yes	Required by NCP and U options.
ntrols	Institutional controls include a variety of measures designed to restrict current and future property owners from taking actions that would expose potential receptors to unacceptable risk, interfere with effectiveness of the final remedial action, and/or convert the site to an end use that is not consistent with the level of remediation. The primary objective of institutional controls is to limit potential for exposure to COIs by restricting access to impacted areas.	Moderate	Standard practice for protecting human health and the environment, effectiveness governed by maintenance of institutional controls.	High	Easily implemented	Low	Low capital and O&M costs.	Yes	Institutional controls imp health and the environn meet the requirements
over	A vegetative cover restricts exposure pathways of potential receptors to affected media.	Moderate	Covers are an effective means of restricting exposure and allow natural attenuation to occur.	High	Readily implementable.	Moderate	Low capital and O&M costs.	Yes	Conventional technolog
g	In-situ soil mixing encapsulates contaminants in solidified media by in-situ mixing of impacted soil with solidifying reagents (e.g., cement, bentonite). This process option does not destroy COIs, but incorporates them into a dense, homogeneous, low-permeability structure that reduces concentrations and mobility	Moderate - High	Provides effective mitigation of risks to receptors.	Moderate -Low	Applicable to all constituents	Moderate - High	High capital costs.	Yes	ISM provides effective r each AOC.
raction	Utilizes induced vacuum in the vadose zone to capture volatiles in the subsurface.	Low - Moderate	Variability of constituents triggering exceedances within each area, SVE, MPE, and thermal will not be effective at remediating most COIs present in OU-E.	Moderate - High	Implementation of extraction is limited to constituent with sufficient volatility to be removed in the vapor phase.	Moderate to high	Capital cost associated with treatment system installation is expensive per level of effectiveness on a comparative basis.	No	The capital cost associa effectiveness on a comp
raction								No	
								No	
ation	Uses fungi such as mushrooms to potentially remove, transfer, stabilize, and destroy COIs in soil.	Low		Low	Mycoremediation within OU-E is not feasible throughout the full depth of affected soil. Further, Mycoremediation was not shown to be effective in previous studies.	Moderate	Cost to apply Mycoremediation would be high relative to other options based on the low treatment effectiveness measured in the previous studies.	No	A total of 30 fungal stra sediments; nine of thes showed the greatest gro dioxin/furan degradatio samples containing fung discernable degradation
dation	Chemical oxidation involves mixing additives (such as sodium persulfate) in-situ to induce reduction/oxidation reactions that chemically convert hazardous contaminants to non-hazardous or less toxic compounds that are more stable or inert.	Low	Effective on small portion of constituents in soil and effectiveness must be evaluated by treatability test or bench scale study. Would generate secondary effects that degrade soil and groundwater quality.	Low - Moderate	Implementation for a small portions of areas of concern	Moderate - High	High implementation costs.	No	Considering implementa
ng	Process option that consists of spreading the excavated soils in windrows to stimulate aerobic microbial activity through aeration and/or the addition of minerals, nutrients, and moisture to expedite treatment.	Moderate	Effective for reduction of volatile COIs. Ineffective for metals and dioxin.	Moderate - High	Readily implementable and effective for reduction of volatile constituents. Site disturbance is high as soil needs to be spread to be effective.	High	Excavation and land farming costs can be similar to excavation and disposal depending on the timeframe required for COIs to degrade.	Yes	Land farming may be si number of COIs.
	Involves heaping impacted excavated soils into aboveground storage cells and stimulating aerobic microbial activity via aeration and/or addition of minerals, nutrients, and moisture.	Moderate	Requires bench-scale study and/or a pilot test prior to the determination of site-specific effectiveness.	Moderate-high	Implementable with similar space and site disturbance issues as landfarming.	High	High capital and O&M costs.	No	Uncertain and compara treatment/disposal meth
isposal	Physical removal of impacted soil with offsite landfill disposal.	High	Immediately effective	Moderate - High	Readily implementable and effective for reduction of all constituents.	High	High capital and O&M costs.	Yes	Excavation is technicall removal of COIs from th

evaluated as a stand-alone alternative.
incorporated into the development of action-based alternatives.
n the preliminary screening stage.

Acronyms:
COI - chemical of interest
DGR - directed groundwater recirculation
ISB - in-situ bioremediation
LUC - land use control
NCP - National Contingency Plan
O&M - operation and maintenance
SVE - soil vapor extraction
USEPA - United States Environmental
VAFB - Vandenberg Air Force Base
VOC(s) - volatile organic compounds

...ption	Description	Effectiveness Evaluation		Implementability Evaluation		Relative Cost Evaluation		Retained?
...on	No remedial action	---		---		---		Yes
...ontrols	Institutional controls include a variety of measures designed to restrict current and future property owners from taking actions that would expose potential receptors to unacceptable risk, interfere with effectiveness of the final remedial action, and/or convert the site to an end use that is not consistent with the level of remediation. The primary objective of institutional controls is to limit potential for exposure to COIs by restricting access to impacted areas. The Mill Pond Dam and beach berm would continue to provide sediment containment.	Moderate	Standard practice for protecting human health and the environment, effectiveness governed by maintenance of institutional controls.	High	Easily implemented	Low	Low capital and O&M costs.	Yes
...Cover	A vegetative cover prevents exposure pathways of potential receptors to affected media. The Mill Pond Dam and beach berm would continue to provide sediment containment.	Moderate	A vegetative cover restricts exposure pathways of potential receptors to affected media. Covers installed in aquatic environments with variable storm water flow may be eroded over time.	Moderate - Low	Covers are an effective means of restricting exposure, however placement of covers on geotechnically weak sediments is difficult.	High	Capital cost to install caps over sediment can require sediment stabilization, drainage, or other costs of performing work "in the wet". O&M costs may be high as erosion of caps in dynamic environments may require repair or replacement periodically.	Yes
...ing	ISM technology can be used to immobilize organic and inorganic compounds in saturated sediments, using reagents to produce an inert, geotechnically strong, and relatively less permeable material, such as Portland cement. The Mill Pond Dam and beach berm would continue to provide sediment containment.	High	Incorporates COIs into a dense, homogeneous, low-permeability structure that reduces concentrations and mobility.	Moderate - Low	In-situ mixing can be performed with an excavator bucket or a large diameter crane-mounted auger depending on depth and volume. Work in aquatic environments would destroy habitat and would require significant mitigation.	High	Implementation cost is high to treat wet sediment.	Yes
...diation	Uses fungi such as mushrooms to potentially remove, transfer, stabilize, and destroy COIs in sediment. The Mill Pond Dam and beach berm would continue to provide sediment containment during treatment.	Low	A laboratory study of mycoremediation was prepared by NewFields for use of mushrooms and fungi to remediate dioxins and furans at the Site (NewFields, 2011). The primary objective of this study was to evaluate the potential for various strains of fungi to degrade dioxins/furans in site soils to evaluate whether mycoremediation could be an effective remedial process option at the site. Mycoremediation was not effective during the study.	Low	Mycoremediation within the Pond AOIs with impacts to sediment is not feasible as the sediments are typically submerged. Further, Mycoremediation was not shown to be effective in previous studies.	High	Contact with sediment would require removal from the aquatic environment at high implementation cost.	No
...xidation	Involves injection of substrates into the target media to promote biological degradation of target COCs. The Mill Pond Dam and beach berm would continue to provide sediment containment during treatment.	Low	Achieving significant distribution of reagents is likely not feasible within fine-grained matrices characteristic of the sediments at the site. Biological Oxidation would not be effective for all COIs.	Low	Well installation or direct push injection activities to deliver reagents will be restricted for sediments located in pond areas.	High	High implementation cost	No
...xidation	Chemical oxidation involves mixing additives (such as sodium persulfate) in-situ to induce reduction/oxidation reactions that chemically convert hazardous contaminants to non-hazardous or less toxic compounds that are more stable or inert. The Mill Pond Dam and beach berm would continue to provide sediment containment during treatment.	Low	Achieving significant distribution of reagents is likely not feasible within fine-grained matrices characteristic of the sediments at the site. Chemical Oxidation would not be effective for all COIs.	Low	Injecting oxidizing chemicals in sediment would be harmful to the existing biota and would not be permittable.	High	High implementation cost	No
...ning ...g	Physical removal and tilling of impacted sediment. Affected sediment is periodically turned over to re-aerate. Amendments may be added to aid the composting processes.	Low	The nature of COIs driving risk within the sediment AOIs, biological treatment will not be sufficient to reduce COI concentrations to meet target cleanup goals and achieve RAOs.	Moderate - High	Can be readily implemented for sediment	Moderate	Moderate capital and high O&M cost	No
...Disposal	Physical removal of impacted sediment with offsite landfill disposal.	High	Immediately effective and readily implementable.	Moderate - High	Readily implementable.	High	Moderate - high capital cost and low O&M cost.	Yes

...evaluated as a stand-alone alternative.
...n the preliminary screening stage.

Option	Description	Effectiveness Evaluation		Implementability Evaluation		Relative Cost Evaluation		Retained?
tion	No remedial action	---		---		---		Yes
Controls	Institutional controls are administrative actions that minimize exposure by limiting land or resource use; institutional controls maintain protectiveness by modifying or guiding human behavior.	Moderate	Standard practice for protecting human health and the environment, effectiveness governed by maintenance of institutional controls.	Moderate - High	Generally implementable but requires close coordination of regulatory authorities.	Low	Low capital and O&M costs.	Yes
Natural ation	Monitoring events are performed to confirm that COI concentrations are attenuating over time via natural subsurface processes.	Moderate	Natural attenuation processes is effective for reduction of COIs.	High	Readily implementable.	Low	Low capital and O&M costs; existing infrastructure can be used for groundwater monitoring.	Yes
Barrier	Installation of an impermeable containment barrier downgradient of COI-impacted soil/groundwater extending through the water table to COI prevent mobility.	Moderate - High	Effective for restricting movement of COIs.	Moderate	May require specialized equipment to construct slurry walls or sheet pile walls. May not be implementable in wetland areas.	Moderate	High capital cost for barrier installation	No
Soil Vapor ction	Injection of air below the groundwater table to physically strip volatile COIs from groundwater. Air sparging also has a limited ability to increase background oxygen concentrations and promotes aerobic biodegradation processes.	Moderate	Low volatility of diesel phase COCs may limit effectiveness.	Moderate - High	Is readily implementable for fuel constituents in groundwater in the IRM and West of IRM AOIs	Low	High capital and O&M costs.	Yes
mal	Thermal remediation relies upon heating groundwater using a variety of technologies to enhance volatization of constituents and capturing COIs with SVE	Moderate - High	Effective for mass removal in groundwater	Moderate - High	Is readily implementable for fuel constituents in groundwater in the IRM and West of IRM AOIs	High	Significant capital and O&M costs for implementation	No
Aerobic diation	The injection of a substrate (such as calcium peroxide) to stimulate native microorganisms and degrade COIs via the addition of oxygen as an electron acceptor.	Moderate - High	Effective and implementable for remediation of VOCs and other fuel-related constituents.	Moderate - High	Effective and implementable for remediation of VOCs and other fuel-related constituents.	Moderate	Moderate capital and O&M costs	Yes
Anaerobic diation	The injection of a substrate (such as magnesium sulfide) to stimulate native microorganisms and degrade COIs via the addition of an electron acceptor in a low-oxygen or oxygen-free environment.		Injection of a non-oxygen electron acceptor to stimulate enhanced anaerobic bioremediation is likely to affect secondary water quality parameters in the short term.			Moderate	Moderate capital and O&M costs	Yes
ediation	Uses plants to potentially remove, transfer, stabilize, and destroy COIs in shallow groundwater.	Moderate	Effectiveness of phytoremediation at the site is unknown, and would require treatability studies to establish remedial timeframes.	Moderate	The average depth of groundwater near the OU-E Groundwater AOC, a tree/shrub plantation with roots extending 10 to 15 feet bgs would likely be the main application for treatment.	Low	Low capital and O&M costs.	No
Oxidation	Use of chemical oxidant (ozone, hydrogen peroxide, persulfate, or permanganate) to oxidize COIs in-situ.	Moderate	ISCO is an established technology that can be effective for petroleum constituents.	Moderate - High	Redox reactions can generate byproducts that impact water quality.	Moderate	Moderate capital and O&M costs	No
active Barrier	Consists of a subsurface emplacement of reactive materials (zero valent iron) built below ground to intercept and treat COI-affected groundwater. A PRB is built by excavating a narrow trench perpendicular to the path of the COIs in groundwater.	Low	Effectiveness is tied to groundwater flushing across the AOC and reactivity with the barrier materials.	Low	Challenging to implement in the site setting at OU-E	Moderate	High capital and O&M cost	No
(reinjection)	COIs in extracted groundwater are removed through a series of process methods including physical, chemical, or biological treatment, such as granular activated carbon and air stripping. Treated groundwater is reinjected into groundwater table.	High	Technology is proven to be effective.	High	Feasible at site	High	High capital and O&M costs.	No
t (disposal)	COIs in extracted groundwater are removed through a series of process methods including physical, chemical, or biological treatment, such as granular activated carbon and air stripping.	High	Technology is proven to be effective.	High	Feasible at site	High	High capital and O&M cost	Yes

evaluated as a stand-alone alternative.
n the preliminary screening stage.

...k Summary	Alternative	Description	Threshold (Yes or No) Criteria		Balancing (Low, Moderate, or High) C...		
			Overall Protection of Human Health and the Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short Term Effectiveness
...Q are the primary risk drivers in ...isks evaluated in the BHHERA ...-06 for sediments 0-0.5 feet in ...r sediments 0-2 feet in depth.	No Action	Site remains as is; provide no additional control or action to protect human health or the environment from affected sediment.	No	No	Low	Low	High
	Institutional Controls	Restrict future land use via deed restriction and implement risk management plan for soil/sediment based on COIs and associated risks.	Yes	Yes	Moderate	Low	High
	Vegetative Soil Cover and Institutional Controls	Provide an upland vegetative cover to cover each individual pond. Eliminate exposure pathways through vegetative containment, and implementation of a deed restriction and risk management plan for soil/sediment based on COIs and associated risks.	Yes	Yes	Moderate	Low	High
	Excavation and Disposal	Eliminate exposure pathways through soil excavation and disposal offsite at a permitted landfill.	Yes	Yes	High	High	Low
	Vegetative Sediment Cover and Institutional Controls	Provide a vegetative wetland cover to cover each individual pond. Eliminate exposure pathways through vegetative containment, and implementation of a deed restriction and risk management plan for soil/sediment based on COIs and associated risks.	Yes	Yes	Moderate	Low	High
...Q are the primary risk drivers in ...sks evaluated in the BHHERA ...e ELCR of 2E-05.	No Action	Site remains as is; provide no additional control or action to protect human health or the environment from affected sediment. Existing beach berm would continue to provide sediment containment.	No	No	Low	Low	High
	Institutional Controls	Restrict future land use via deed restriction and implement risk management plan for soil/sediment based on COIs and associated risks. Beach berm repairs provide improved sediment containment.	Yes	Yes	Moderate	Low	High
	Vegetative Soil Cover and Institutional Controls	Provide an upland vegetative cover to cover the pond. Eliminate exposure pathways through vegetative containment, and implementation of a deed restriction and risk management plan for soil/sediment based on COIs and associated risks. Beach berm repairs provide improved sediment containment.	Yes	Yes	Moderate	Low	High
	Excavation and Disposal	Eliminate exposure pathways through soil excavation and disposal offsite at a permitted landfill. Beach berm repairs provide improved sediment containment.	Yes	Yes	High	High	Low
	Vegetative Sediment Cover and Institutional Controls	Provide a vegetative wetland cover to cover the pond. Eliminate exposure pathways through vegetative containment, and implementation of a deed restriction and risk management plan for soil/sediment based on COIs and associated risks. Beach berm repairs provide improved sediment containment.	Yes	Yes	Moderate	Low	High

k Summary	Alternative	Description	Threshold (Yes or No) Criteria		Balancing (Low, Moderate, or High) C		
			Overall Protection of Human Health and the Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short Term Effectiveness
Q are the primary risk drivers in ile arsenic was the primary risk nd sediment. Risks evaluated in ndicate ELCR of 2E10-6.	No Action	Site remains as is; provide no additional control or action to protect human health or the environment from affected sediment. Existing beach berm would continue to provide sediment containment.	No	No	Low	Low	High
	Institutional Controls	Restrict future land use via deed restriction and implement risk management plan for soil/sediment based on COIs and associated risks. Beach berm repairs provide improved sediment containment.	Yes	Yes	Moderate	Low	High
	Vegetative Soil Cover and Institutional Controls	Provide an upland vegetative cover to cover the pond. Eliminate exposure pathways through vegetative containment, and implementation of a deed restriction and risk management plan for soil/sediment based on COIs and associated risks. Beach berm repairs provide improved sediment containment.	Yes	Yes	Moderate	Low	High
	Excavation and Disposal	Eliminate exposure pathways through soil excavation and disposal offsite at a permitted landfill.	Yes	Yes	High	High	Low
	Vegetative Sediment Cover and Institutional Controls	Provide a vegetative wetland cover to cover the pond. Eliminate exposure pathways through vegetative containment, and implementation of a deed restriction and risk management plan for soil/sediment based on COIs and associated risks.	Yes	Yes	Moderate	Low	High
imary risk drivers in sediment. e BHHERA indicate ELCRs are th the primary contributors of d 1E-6 for arsenic. Arsenic ns are at background.	No Action	Site remains as is; provide no additional control or action to protect human health or the environment from affected sediment. Mill Pond Dam continues to provide sediment containment.	No	No	Low	Low	High
	Institutional Controls	Restrict future land use via deed restriction and implement risk management plan for soil/sediment based on COIs and associated risks. Dam repairs provide improved sediment containment.	Yes	Yes	High	Moderate	High
	In-Situ Soil Mixing and Institutional Controls	Proposes to treat sediment in place through stabilization by the addition of binders and Portland cement to restrict exposure of potential receptors to affected media, and would limit potential direct contact with affected sediment, or infiltration of water. Dam repairs provide improved sediment containment.	Yes	Yes	High	Moderate	Low
	Excavation and Disposal	Eliminate exposure pathways through excavation and disposal offsite at a permitted landfill. Dam repairs provide improved sediment containment.	Yes	Yes	High	High	Low
	Vegatative Sediment Cover and Institutional Controls	Provide a vegetative wetland cover to cover the pond. Eliminate exposure pathways through vegetative containment, and implementation of a deed restriction and risk management plan for soil/sediment based on COIs and associated risks. Dam repairs provide improved sediment containment.	Yes	Yes	Low	Moderate	High
	Vegetated Soil Cover and Institutional Controls	Alternative proposes to provide a vegetative cover to cover the pond to restrict exposure of potential receptors to affected media, and would limit potential direct contact with affected sediment, or infiltration of water. Dam repairs provide improved sediment containment.	Yes	Yes	Moderate	Low	High

...k Summary	Alternative	Description	Threshold (Yes or No) Criteria		Balancing (Low, Moderate, or High) C...		
			Overall Protection of Human Health and the Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short Term Effectiveness
...nts (TPHd) and Barium are the ...ncentrations of Barium show ...ar the WQO, which is also the ...of TPHd show downward trends ... is based on the taste and odor ...threshold.	No Action	Site remains as is; provide no additional control or action to protect human health or the environment from affected groundwater.	No	No	Low	Moderate	High
	Restricted Use	A deed restriction on the AOC, prohibiting the use of groundwater to eliminate exposure to COIs.	Yes	Yes	Moderate	Moderate	High
	Monitored Natural Attenuation and Institutional Controls	Periodic sampling of groundwater to evaluate natural biological and chemical remediation of COIs with contingency for potential future remedial actions, and restrict future groundwater use by establishing a deed restriction prohibiting use of onsite groundwater.	Yes	Yes	Moderate	Moderate	High
	Enhanced Aerobic Bioremediation, MNA, and Institutional Controls	Injection of calcium peroxide solution for treatment of contaminants followed by periodic groundwater sampling to confirm that WQOs will be reached within a reasonable timeframe. Periodic sampling of groundwater to evaluate natural biological and chemical remediation of COIs with contingency for potential future remedial actions, and restrict future groundwater use by establishing a deed restriction prohibiting use of onsite groundwater. Only effective for petroleum related compounds.	Yes	Yes	High	High	Moderate
	Enhanced Anaerobic Bioremediation, MNA, and Institutional Controls	Anaerobic bio-oxidation of COIs followed by treatment through natural attenuation mechanisms. Periodic sampling of groundwater to evaluate natural biological and chemical remediation of COIs with contingency for potential future remedial actions, and restrict future groundwater use by establishing a deed restriction prohibiting use of onsite groundwater. Only effective for petroleum related compounds.	Yes	Yes	High	High	Moderate

...et or has a high ranking in preference.

...ely met or has a moderate ranking in preference.

...ot be met or has a low ranking in preference.

...Requirements

...Risk Assessment - Operable Unit E (ARCADIS, 2015)

...e of TEQ, 2,3,7,8-tetrachlorodibenzo-p-dioxin [2,3,7,8-TCDD] in particular)

... Pollution Contingency Plan

sk	ELCR	Alternative	Objective	Threshold (Yes or No) Criteria		Balancing (Low, Moderate, or		
				Overall Protection of Human Health and the Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short Term Effectiveness
oxin	2E-6 (12 day 0-2 ft) 2E-6 (12 day 0-0.5 ft) 7E-6 (50 day 0-2 ft) 8E-6 (50 day 0-0.5 ft) All prior to 2017 hot spot removal.	Institutional Controls	Restrict future land use via deed restriction and implement risk management plan for soil/sediment based on COIs and associated risks.	Yes	Yes	Moderate	Low	High
oxin	2E-5 Prior to excavation of full footprint in 2017.	Institutional Controls	Restrict future land use via deed restriction and implement risk management plan for soil/sediment based on COIs and associated risks. Beach berm repairs provide improved sediment containment.	Yes	Yes	Moderate	Low	High
oxin	2E-6 (North) 3E-6 (Pond 6 0-2ft) 4E-6 (Pond 6 0-0.5 ft)	Institutional Controls	Restrict future land use via deed restriction and implement risk management plan for soil/sediment based on COIs and associated risks. Beach berm repairs provide improved sediment containment.	Yes	Yes	Moderate	Low	High
	2E-6 (1E-6 each for Dioxin and Arsenic, Arsenic concentrations are at background)	Institutional Controls	Restrict future land use via deed restriction and implement risk management plan for soil/sediment based on COIs and associated risks. Mill Pond Dam repairs provide improved sediment containment.	Yes	Yes	High	Moderate	High
l marily ium	NA	Monitored Natural Attenuation and Institutional Controls	Periodic sampling of groundwater to evaluate natural biological and chemical remediation of COIs with contingency for potential future remedial actions, and restrict future groundwater use by establishing a deed restriction prohibiting use of onsite groundwater.	Yes	Yes	Moderate	Moderate	High

iteria is met or has a high ranking in preference.

iteria is likely met or has a moderate ranking in preference.

ay not be met or has a low ranking in preference.

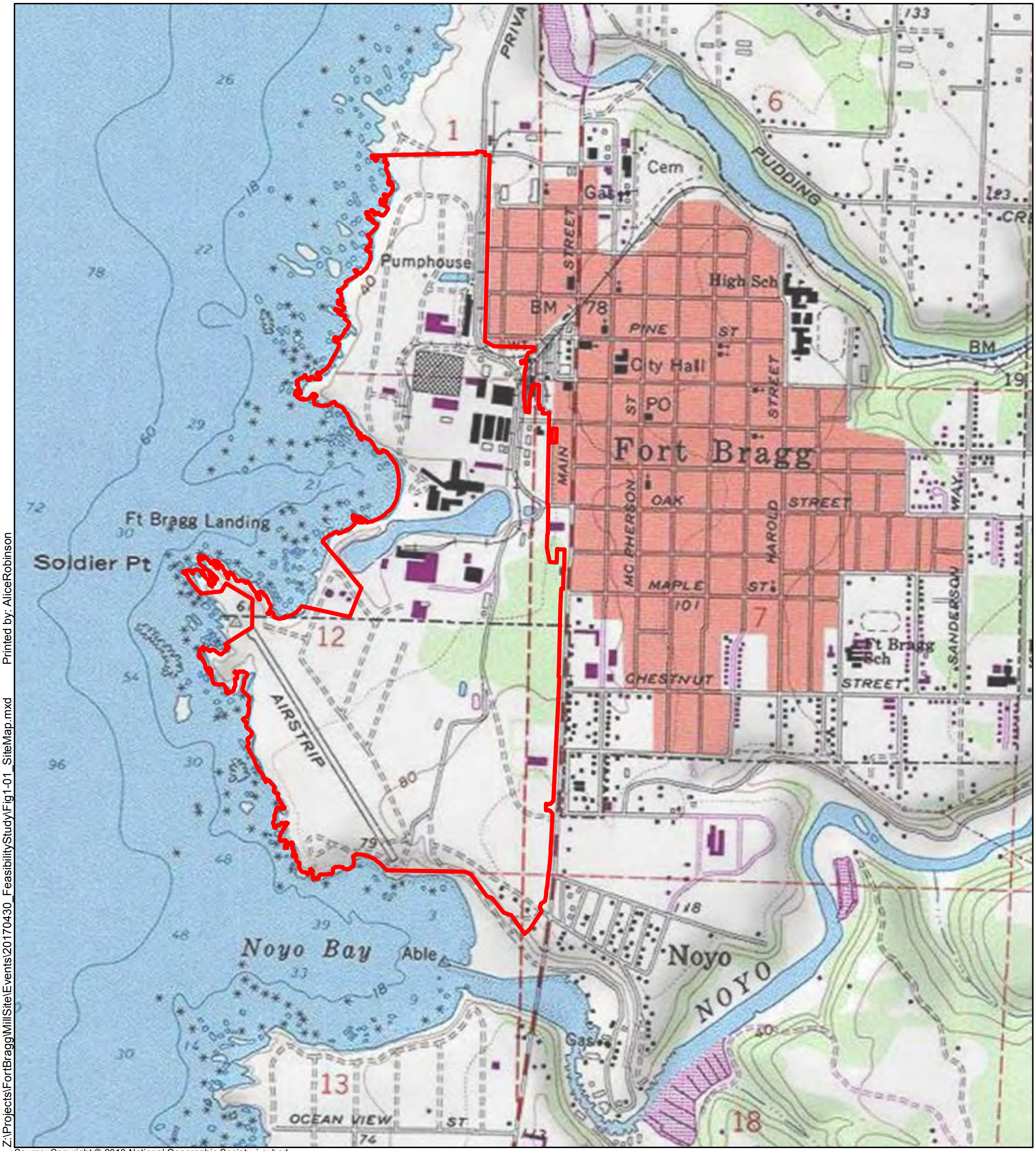
priate Requirements

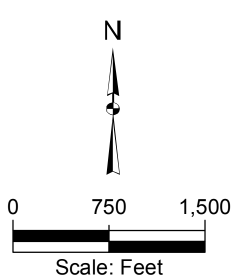
in case of TEQ, 2,3,7,8-tetrachlorodibenzo-p-dioxin [2,3,7,8-TCDD] in particular)

iesel

logical Risk Assessment – Operable Unit E , Former Georgia-Pacific Wood Products Facility, Fort Bragg, California. Prepared for Georgia-Pacific LLC. August.

Figures





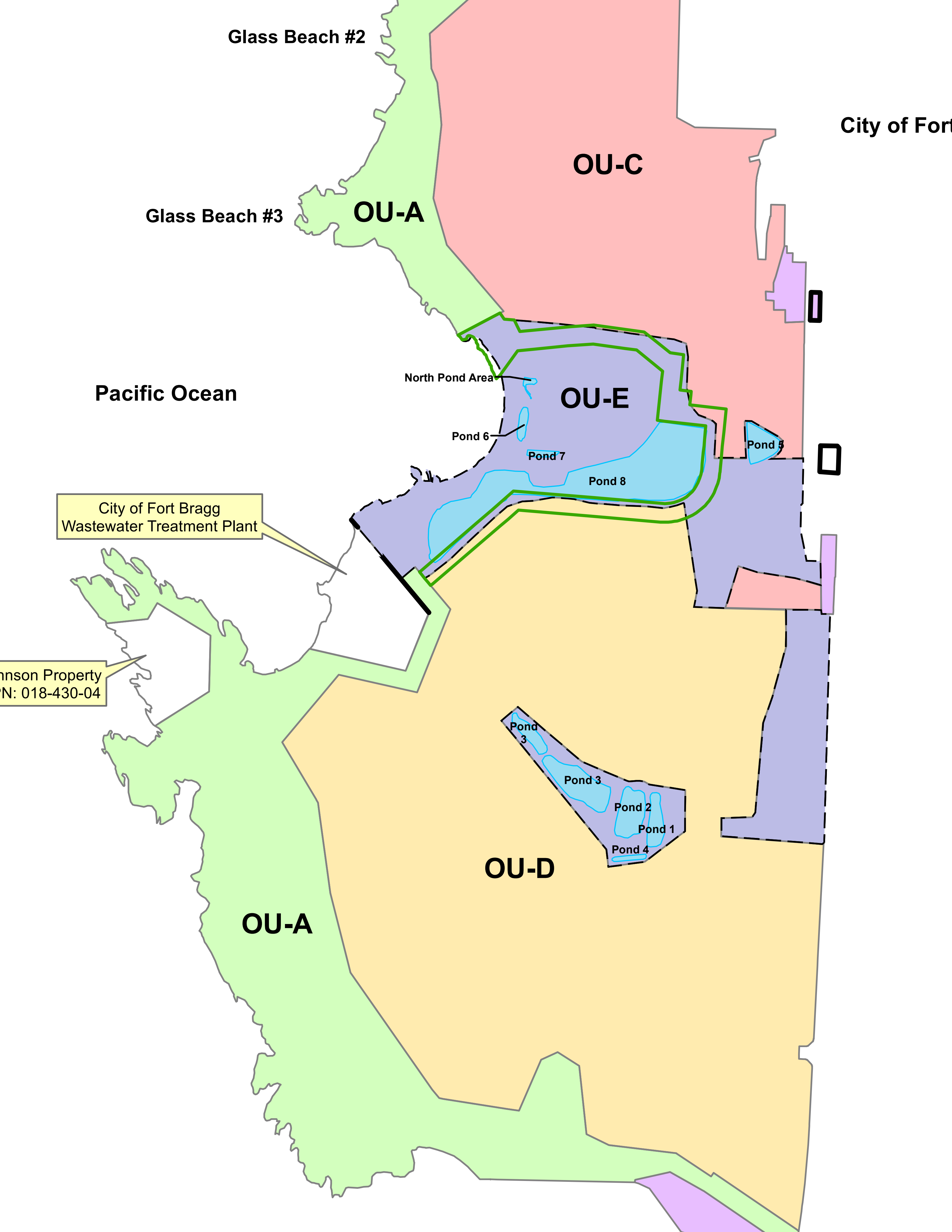
Kennedy/Jenks Consultants

Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

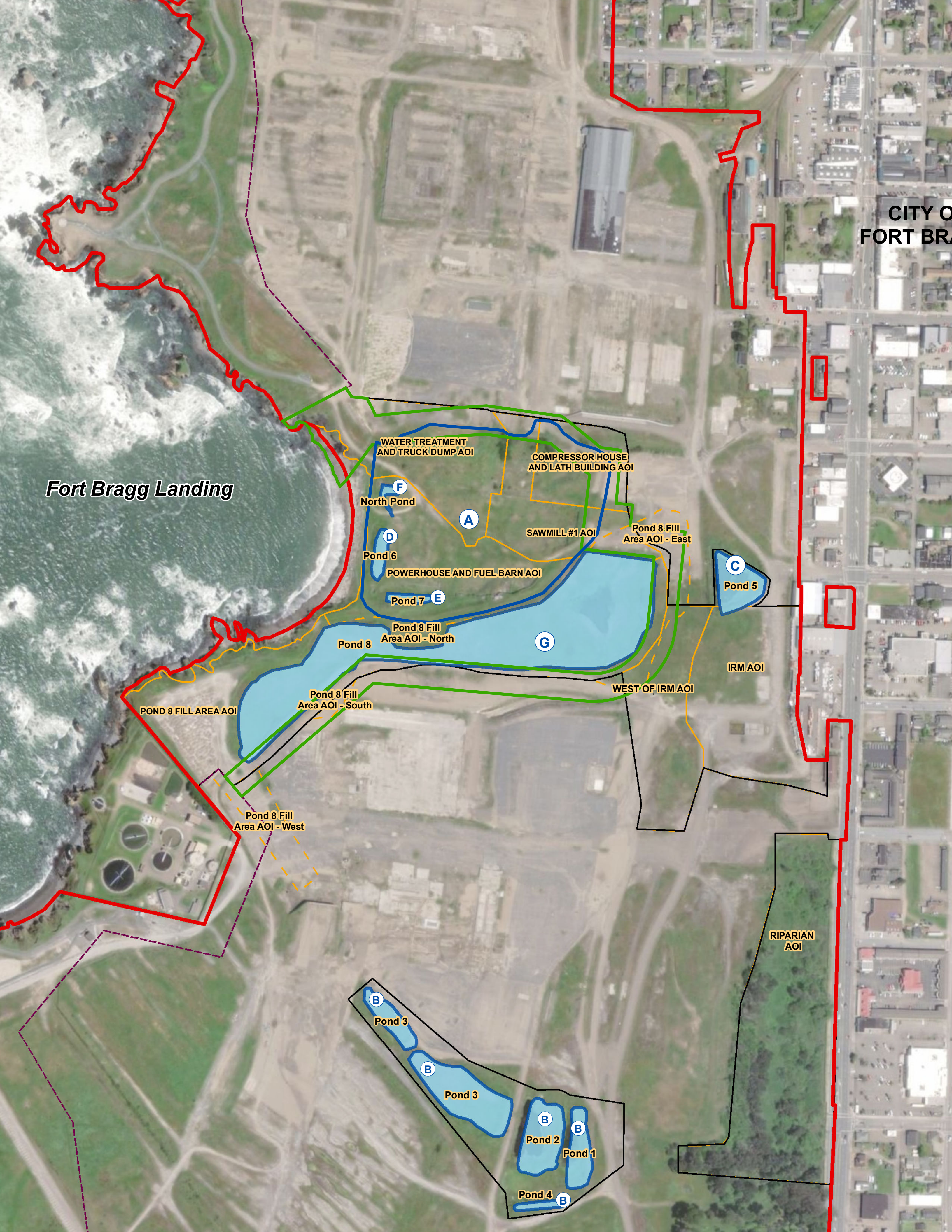
Site Location Map

1665018*18

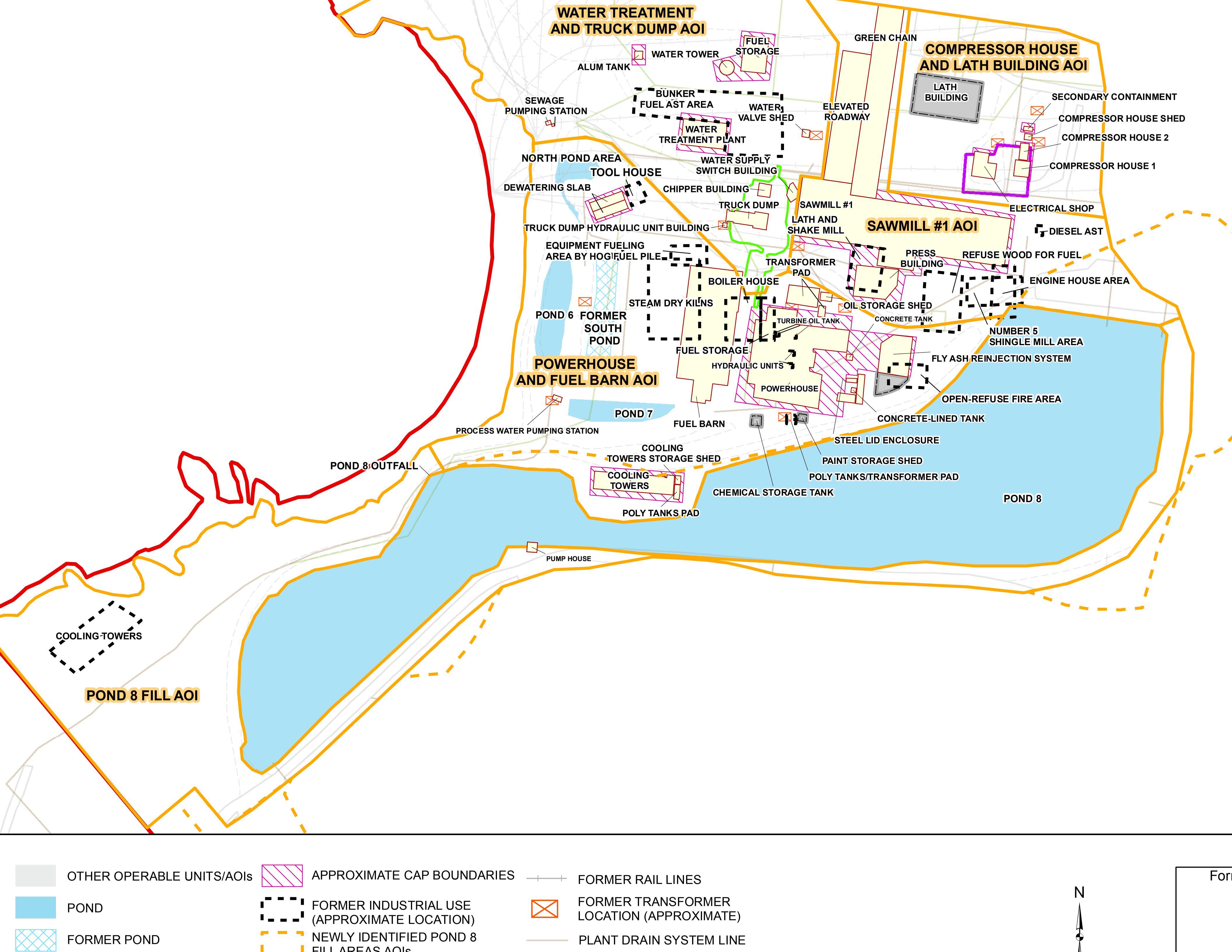
Figure 1-1

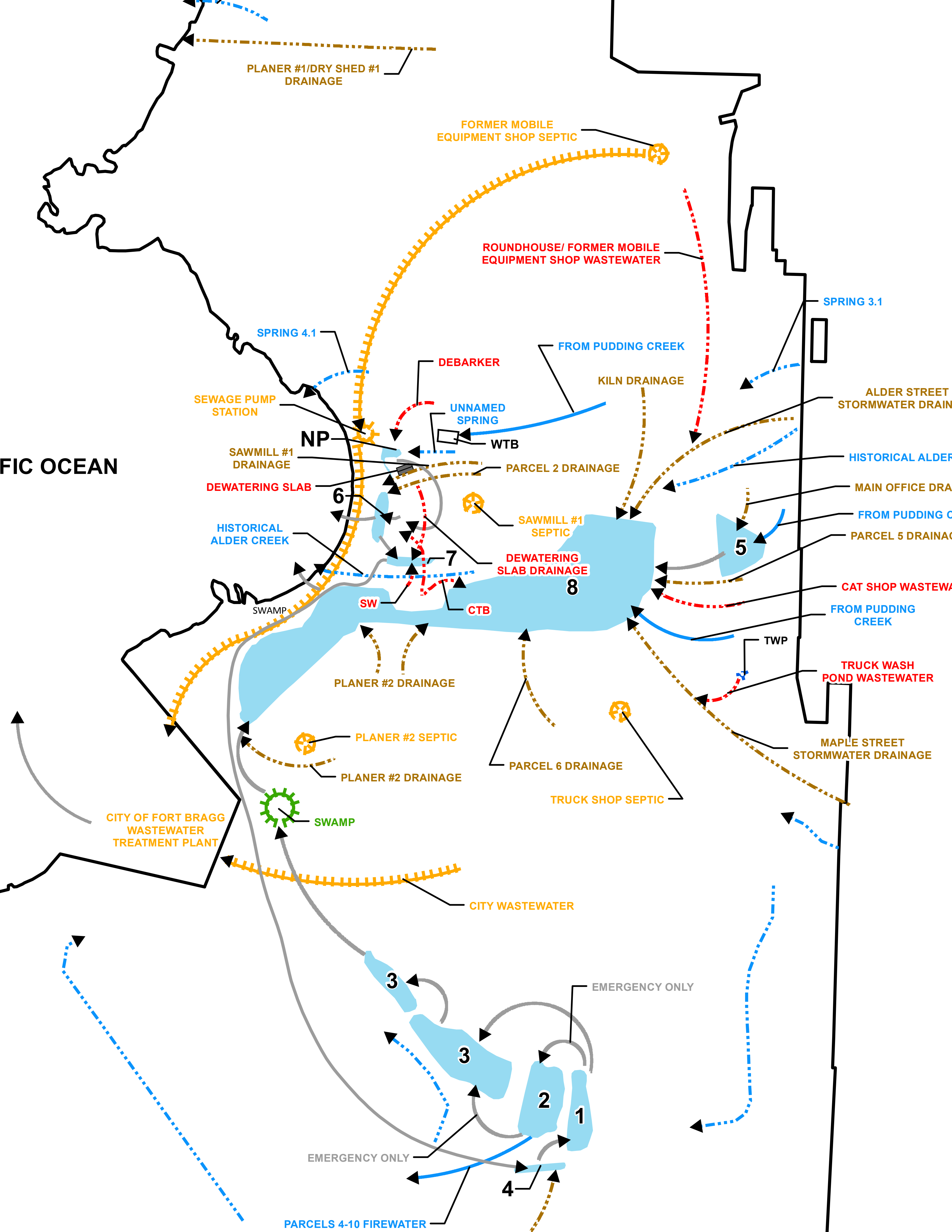


Glass Beach #2
City of Fort
OU-C
Glass Beach #3
OU-A
North Pond Area
OU-E
Pacific Ocean
Pond 6
Pond 7
Pond 5
Pond 8
City of Fort Bragg
Wastewater Treatment Plant
nnson Property
PN: 018-430-04
Pond
3
Pond 3
Pond 2
Pond 1
Pond 4
OU-D
OU-A



CITY OF
FORT BRA
Fort Bragg Landing
WATER TREATMENT
AND TRUCK DUMP AOI
COMPRESSOR HOUSE
AND LATH BUILDING AOI
F
North Pond
A
D
Pond 6
SAWMILL #1 AOI
Pond 8 Fill
Area AOI - East
C
Pond 5
POWERHOUSE AND FUEL BARN AOI
Pond 7
E
Pond 8 Fill
Area AOI - North
Pond 8
G
IRM AOI
WEST OF IRM AOI
Pond 8 Fill
Area AOI - South
POND 8 FILL AREA AOI
Pond 8 Fill
Area AOI - West
RIPARIAN
AOI
B
Pond 3
B
Pond 3
B
Pond 2
B
Pond 1
Pond 4
B


WATER TREATMENT AND TRUCK DUMP AOI
FUEL STORAGE
WATER TOWER
ALUM TANK
GREEN CHAIN
COMPRESSOR HOUSE AND LATH BUILDING AOI
LATH BUILDING
SECONDARY CONTAINMENT
COMPRESSOR HOUSE SHED
COMPRESSOR HOUSE 2
COMPRESSOR HOUSE 1
SEWAGE PUMPING STATION
BUNKER FUEL AST AREA
WATER VALVE SHED
ELEVATED ROADWAY
WATER TREATMENT PLANT
NORTH POND AREA
WATER SUPPLY SWITCH BUILDING
TOOL HOUSE
DEWATERING SLAB
CHIPPER BUILDING
TRUCK DUMP
SAWMILL #1
LATH AND SHAKE MILL
ELECTRICAL SHOP
SAWMILL #1 AOI
DIESEL AST
TRUCK DUMP HYDRAULIC UNIT BUILDING
EQUIPMENT FUELING AREA BY HOGFUEL PILE
TRANSFORMER PAD
PRESS BUILDING
REFUSE WOOD FOR FUEL
BOILER HOUSE
ENGINE HOUSE AREA
STEAM DRY KILNS
OIL STORAGE SHED
TURBINE OIL TANK
CONCRETE TANK
POND 6
FORMER SOUTH POND
NUMBER 5 SHINGLE MILL AREA
FUEL STORAGE
FLY ASH REINJECTION SYSTEM
HYDRAULIC UNITS
POWERHOUSE AND FUEL BARN AOI
POWERHOUSE
OPEN-REFUSE FIRE AREA
POND 7
FUEL BARN
CONCRETE-LINED TANK
PROCESS WATER PUMPING STATION
STEEL LID ENCLOSURE
COOLING TOWERS STORAGE SHED
PAINT STORAGE SHED
POND 8 OUTFALL
COOLING TOWERS
POLY TANKS/TRANSFORMER PAD
CHEMICAL STORAGE TANK
POND 8
POLY TANKS PAD
PUMP HOUSE
COOLING TOWERS
POND 8 FILL AOI
OTHER OPERABLE UNITS/AOIs
POND
FORMER POND
APPROXIMATE CAP BOUNDARIES
FORMER INDUSTRIAL USE (APPROXIMATE LOCATION)
NEWLY IDENTIFIED POND 8 FILL AREAS AOIs
FORMER RAIL LINES
FORMER TRANSFORMER LOCATION (APPROXIMATE)
PLANT DRAIN SYSTEM LINE
N



PLANER #1/DRY SHED #1 DRAINAGE
FORMER MOBILE EQUIPMENT SHOP SEPTIC
ROUNDHOUSE/ FORMER MOBILE EQUIPMENT SHOP WASTEWATER
SPRING 3.1
SPRING 4.1
FROM PUDDING CREEK
DEBARKER
KILN DRAINAGE
SEWAGE PUMP STATION
UNNAMED SPRING
ALDER STREET STORMWATER DRAIN
NP
WTB
FIC OCEAN
SAWMILL #1 DRAINAGE
PARCEL 2 DRAINAGE
HISTORICAL ALDER
DEWATERING SLAB
MAIN OFFICE DRA
6
SAWMILL #1 SEPTIC
FROM PUDDING C
HISTORICAL ALDER CREEK
PARCEL 5 DRAINAG
5
7
DEWATERING SLAB DRAINAGE
8
CAT SHOP WASTEWA
SWAMP
SW
CTB
FROM PUDDING CREEK
TWP
PLANER #2 DRAINAGE
TRUCK WASH POND WASTEWATER
PLANER #2 SEPTIC
PLANER #2 DRAINAGE
PARCEL 6 DRAINAGE
MAPLE STREET STORMWATER DRAINAGE
TRUCK SHOP SEPTIC
CITY OF FORT BRAGG WASTEWATER TREATMENT PLANT
SWAMP
CITY WASTEWATER
EMERGENCY ONLY
3
3
2
1
EMERGENCY ONLY
4
PARCELS 4-10 FIREWATER

Legend

Present in 1952
Constructed bet
Constructed bet
Constructed bet
Current Extent (
1998)

N

0 100
Scale: Feet


1957: Pond 2 visible


1963: Ponds 1 and 2 visible


1966: Ponds 1 a

Fo


Legend
Maximum Hist
Current Exten
Filled Areas (based
photographs)
Filled betweer
Filled betweer
Filled betweer
N
0
125
2
Scale: Feet

1973

1982

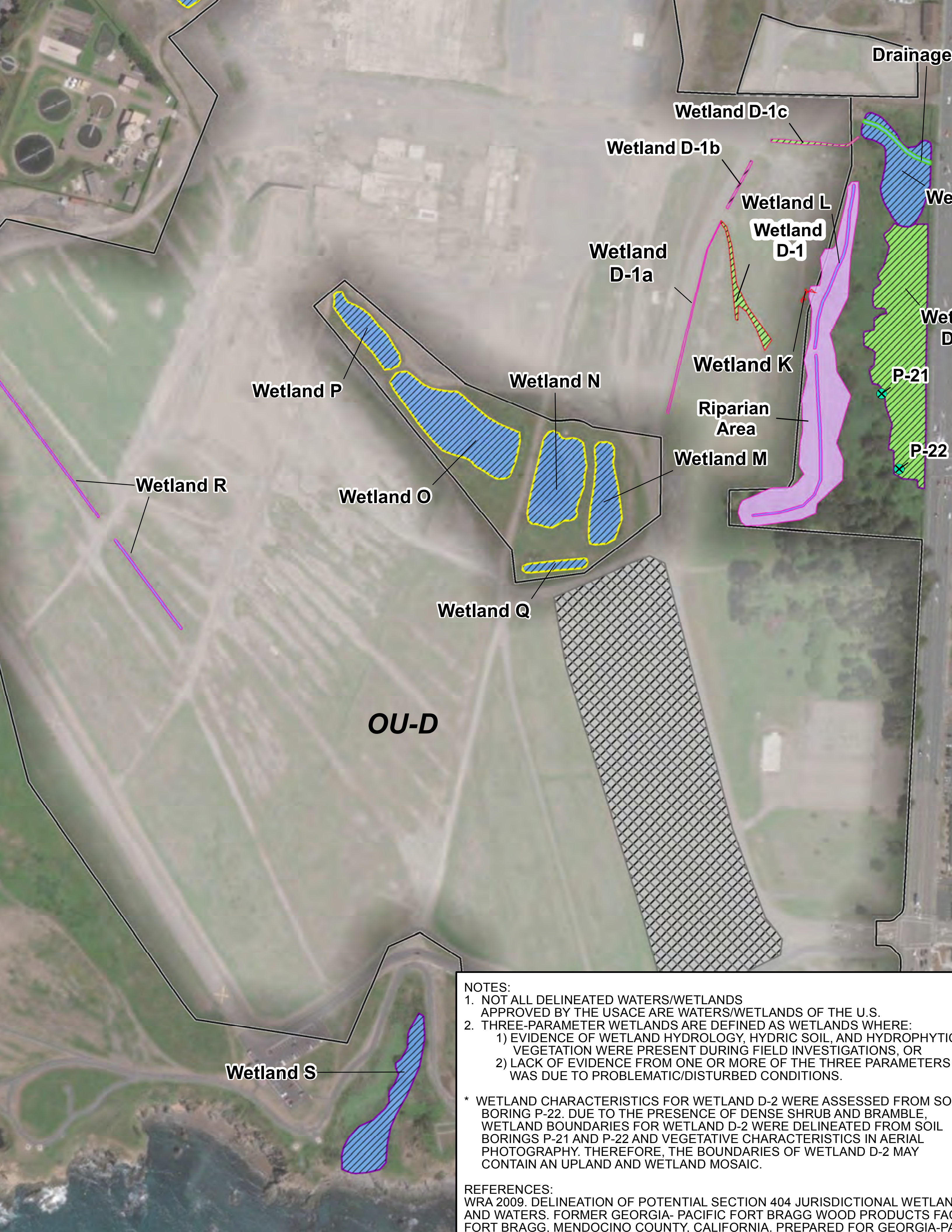
Fo

Pacific Ocean
WEST S
STEWART
MAIN S
FRANKLIN STREET
McPHERSON STREET
N
9
6
6
7
8
8
5
3
3
2
1
4

WETLANDS BOUNDARIES PREVIOUSLY DELINEATED BY WRA (2009)
PROVED BY THE USACE ON MARCH 15, 2010. HOWEVER, NOT ALL
ED WATERS/WETLANDS WERE CLAIMED AS JURISDICTIONAL
SACE. USACE FILE # 2009-00372N.
VIRONMENTALLY SENSITIVE HABITAT AREAS
RAMETER WETLANDS ARE DEFINED AS WETLANDS WHERE:
ENCE OF WETLAND HYDROLOGY, HYDRIC SOIL, AND HYDROPHYTIC
ETATION WERE PRESENT DURING FIELD INVESTIGATIONS, OR
OF EVIDENCE FROM ONE OR MORE OF THE THREE PARAMETERS WAS DUE TO
BLEMATIC/DISTURBED CONDITIONS.

S:

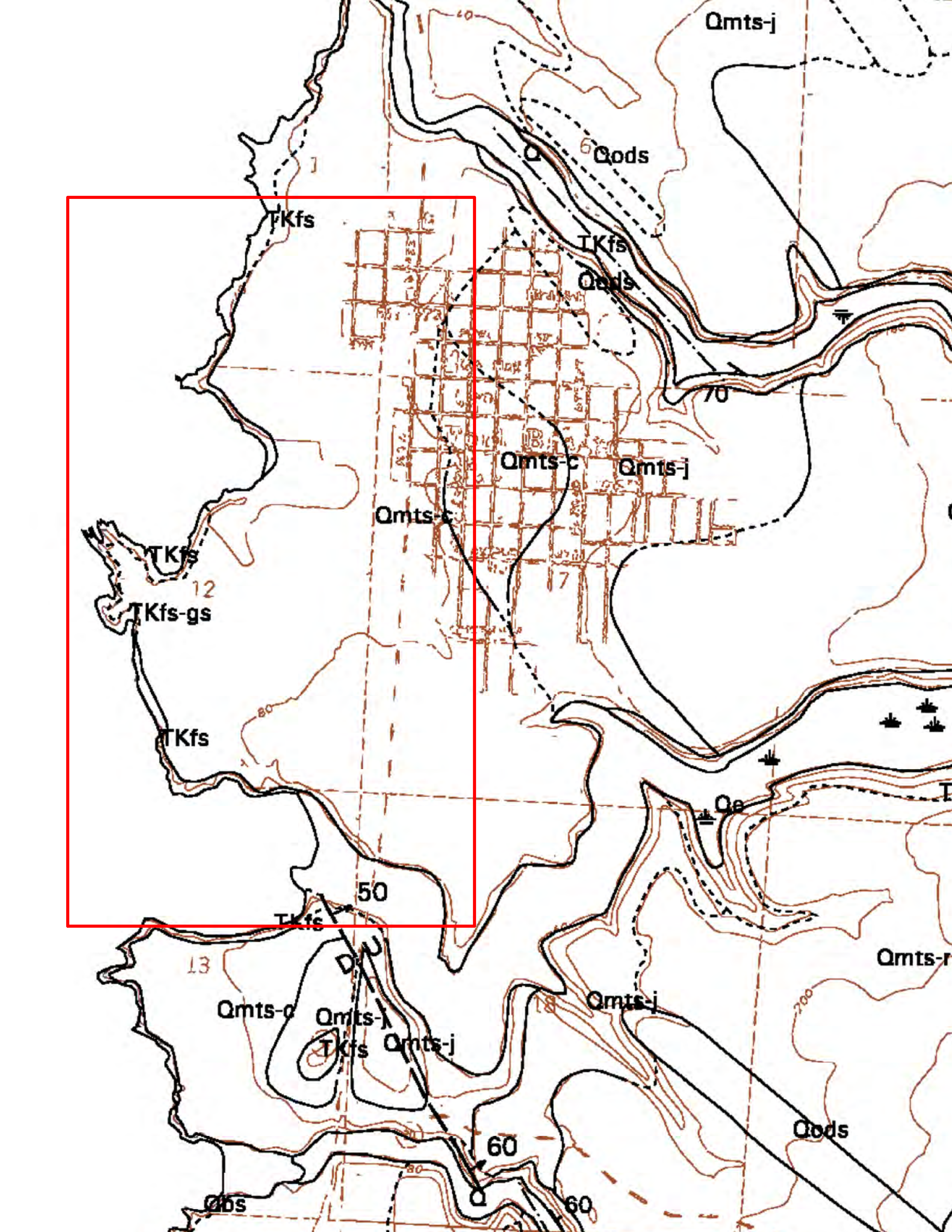
NOTES:
1. NOT ALL DELINEATED WATERS/WETLANDS APPROVED BY THE USACE ARE WATERS/WETLANDS OF THE U.S.
2. ESHA - ENVIRONMENTALLY SENSITIVE HABITAT AREAS
3. THREE-PARAMETER WETLANDS ARE DEFINED AS WETLANDS WHERE:
   1) EVIDENCE OF WETLAND HYDROLOGY, HYDRIC SOIL, AND HYDROPHYTIC VEGETATION WERE PRESENT DURING FIELD INVESTIGATIONS, OR



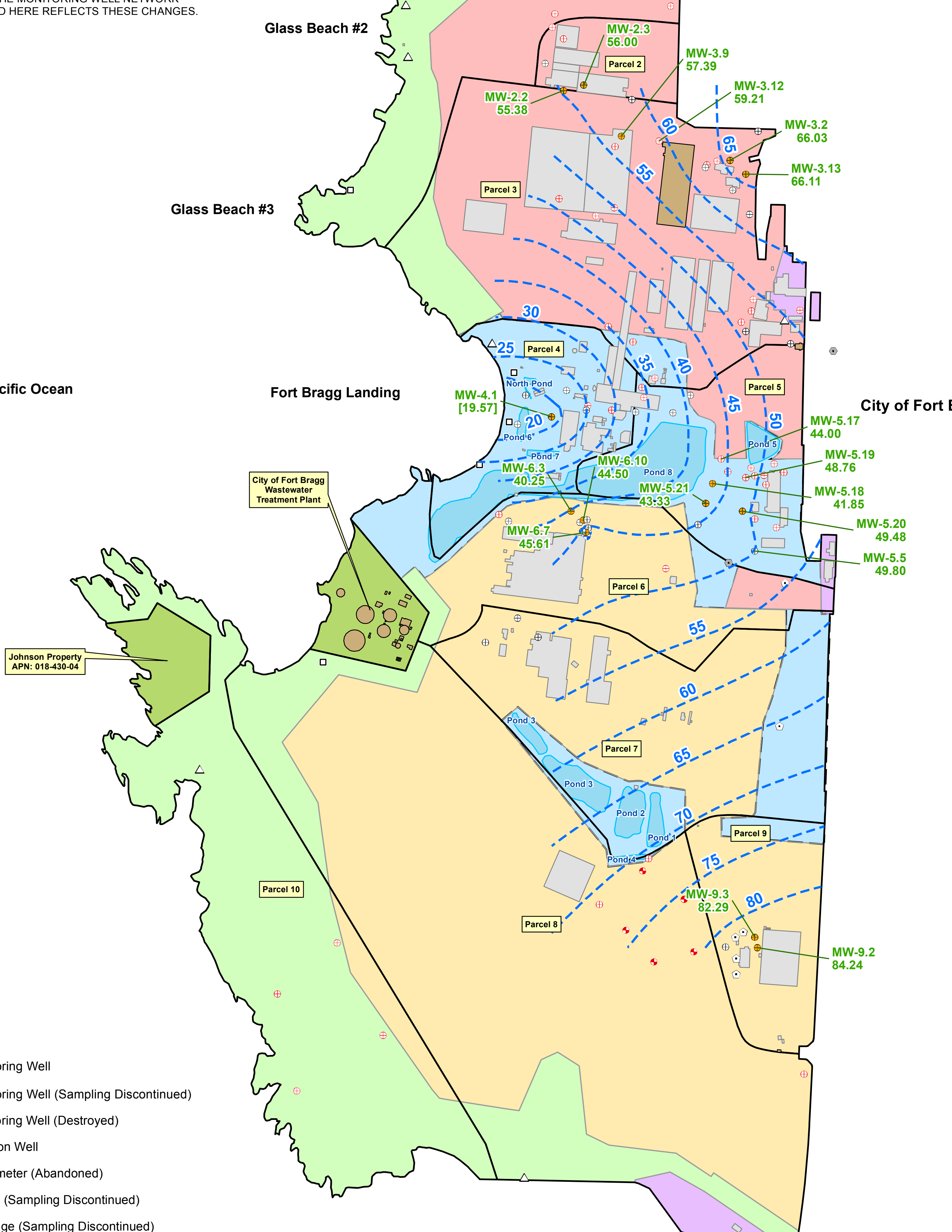
NOTES:
1. NOT ALL DELINEATED WATERS/WETLANDS APPROVED BY THE USACE ARE WATERS/WETLANDS OF THE U.S.
2. THREE-PARAMETER WETLANDS ARE DEFINED AS WETLANDS WHERE:
   1) EVIDENCE OF WETLAND HYDROLOGY, HYDRIC SOIL, AND HYDROPHYTIC VEGETATION WERE PRESENT DURING FIELD INVESTIGATIONS, OR
   2) LACK OF EVIDENCE FROM ONE OR MORE OF THE THREE PARAMETERS WAS DUE TO PROBLEMATIC/DISTURBED CONDITIONS.

* WETLAND CHARACTERISTICS FOR WETLAND D-2 WERE ASSESSED FROM SO BORING P-22. DUE TO THE PRESENCE OF DENSE SHRUB AND BRAMBLE, WETLAND BOUNDARIES FOR WETLAND D-2 WERE DELINEATED FROM SOIL BORINGS P-21 AND P-22 AND VEGETATIVE CHARACTERISTICS IN AERIAL PHOTOGRAPHY. THEREFORE, THE BOUNDARIES OF WETLAND D-2 MAY CONTAIN AN UPLAND AND WETLAND MOSAIC.

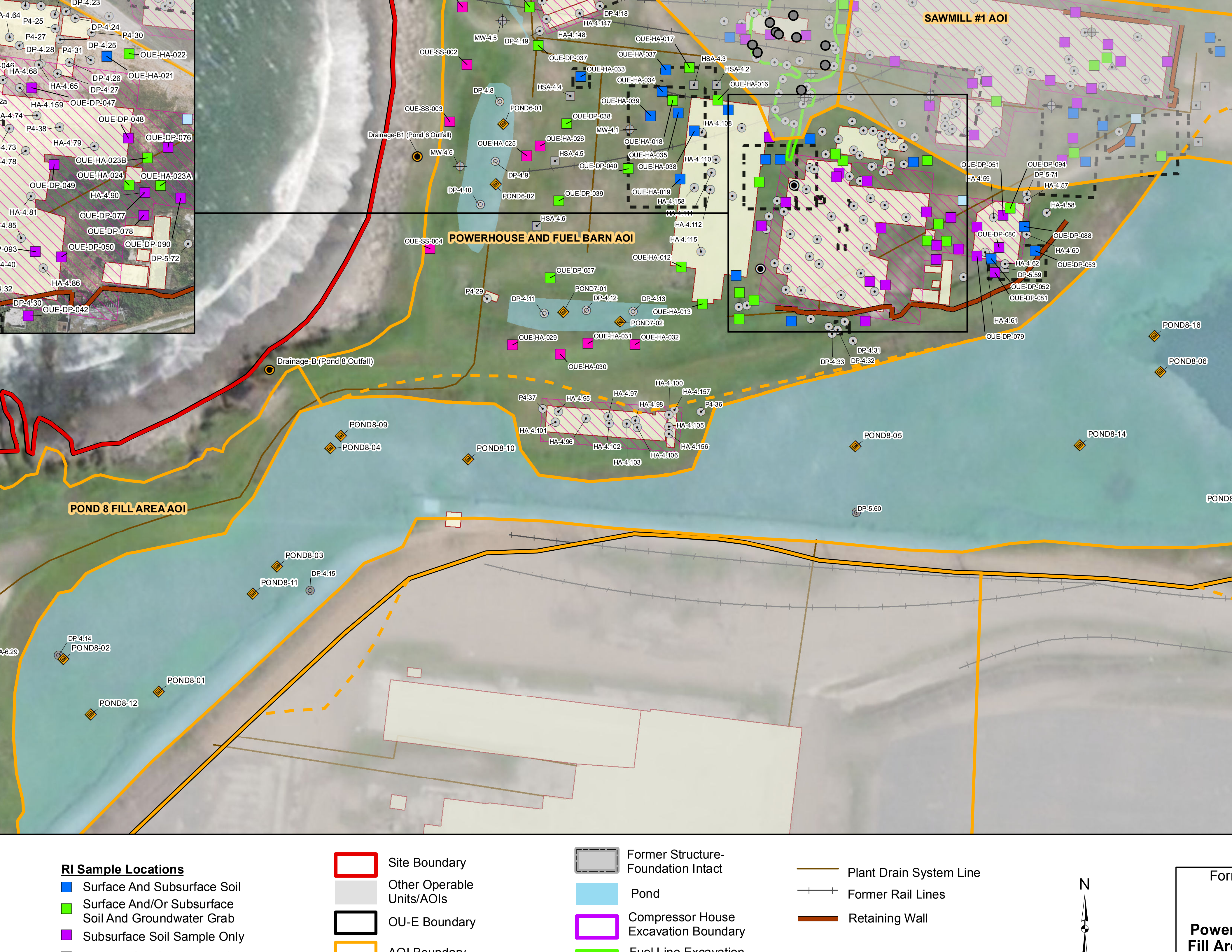
REFERENCES:
WRA 2009. DELINEATION OF POTENTIAL SECTION 404 JURISDICTIONAL WETLAN AND WATERS. FORMER GEORGIA- PACIFIC FORT BRAGG WOOD PRODUCTS FAC FORT BRAGG, MENDOCINO COUNTY, CALIFORNIA. PREPARED FOR GEORGIA-PA



Qmts-j
Qods
TKfs
Qods
70
Qmts-c
Qmts-j
Qmts-c
TKfs
12
TKfs-gs
TKfs
Qe
50
TKfs
13
Qmts-c
Qmts-j
TKfs
Qmts-j
Qmts-j
Qmts-r
Qods
60
Q
60
Qbs



HE MONITORING WELL NETWORK
D HERE REFLECTS THESE CHANGES.
Glass Beach #2
Glass Beach #3
cific Ocean
Fort Bragg Landing
City of Fort B
MW-2.3
56.00
MW-3.9
57.39
MW-3.12
59.21
MW-2.2
55.38
MW-3.2
66.03
MW-3.13
66.11
Parcel 2
Parcel 3
Parcel 4
Parcel 5
Parcel 6
Parcel 7
Parcel 8
Parcel 9
Parcel 10
North Pond
Pond 1
Pond 2
Pond 3
Pond 4
Pond 5
Pond 6
Pond 7
Pond 8
MW-4.1
[19.57]
MW-5.17
44.00
MW-5.19
48.76
MW-6.10
44.50
MW-6.3
40.25
MW-5.21
43.33
MW-5.18
41.85
MW-5.20
49.48
MW-6.7
45.61
MW-5.5
49.80
MW-9.3
82.29
MW-9.2
84.24
City of Fort Bragg
Wastewater
Treatment Plant
Johnson Property
APN: 018-430-04
20
25
30
35
40
45
50
55
60
65
70
75
80
oring Well
oring Well (Sampling Discontinued)
oring Well (Destroyed)
on Well
meter (Abandoned)
(Sampling Discontinued)
ge (Sampling Discontinued)



SAWMILL #1 AOI
POWERHOUSE AND FUEL BARN AOI
POND 8 FILL AREA AOI
Drainage-B1 (Pond 6 Outfall)
Drainage-B (Pond 8 Outfall)
POND8-16
POND8-06
POND8-14
POND8-05
POND8-09
POND8-04
POND8-10
POND8-03
POND8-11
POND8-02
POND8-01
POND8-12
POND7-01
POND7-02
POND6-01
POND6-02
DP-5.60
DP-4.15
DP-4.14
RI Sample Locations
Surface And Subsurface Soil
Surface And/Or Subsurface Soil And Groundwater Grab
Subsurface Soil Sample Only
Site Boundary
Other Operable Units/AOIs
OU-E Boundary
Former Structure-Foundation Intact
Pond
Compressor House Excavation Boundary
Plant Drain System Line
Former Rail Lines
Retaining Wall
N

Other Operable Units/AOIs

OU-E Boundary

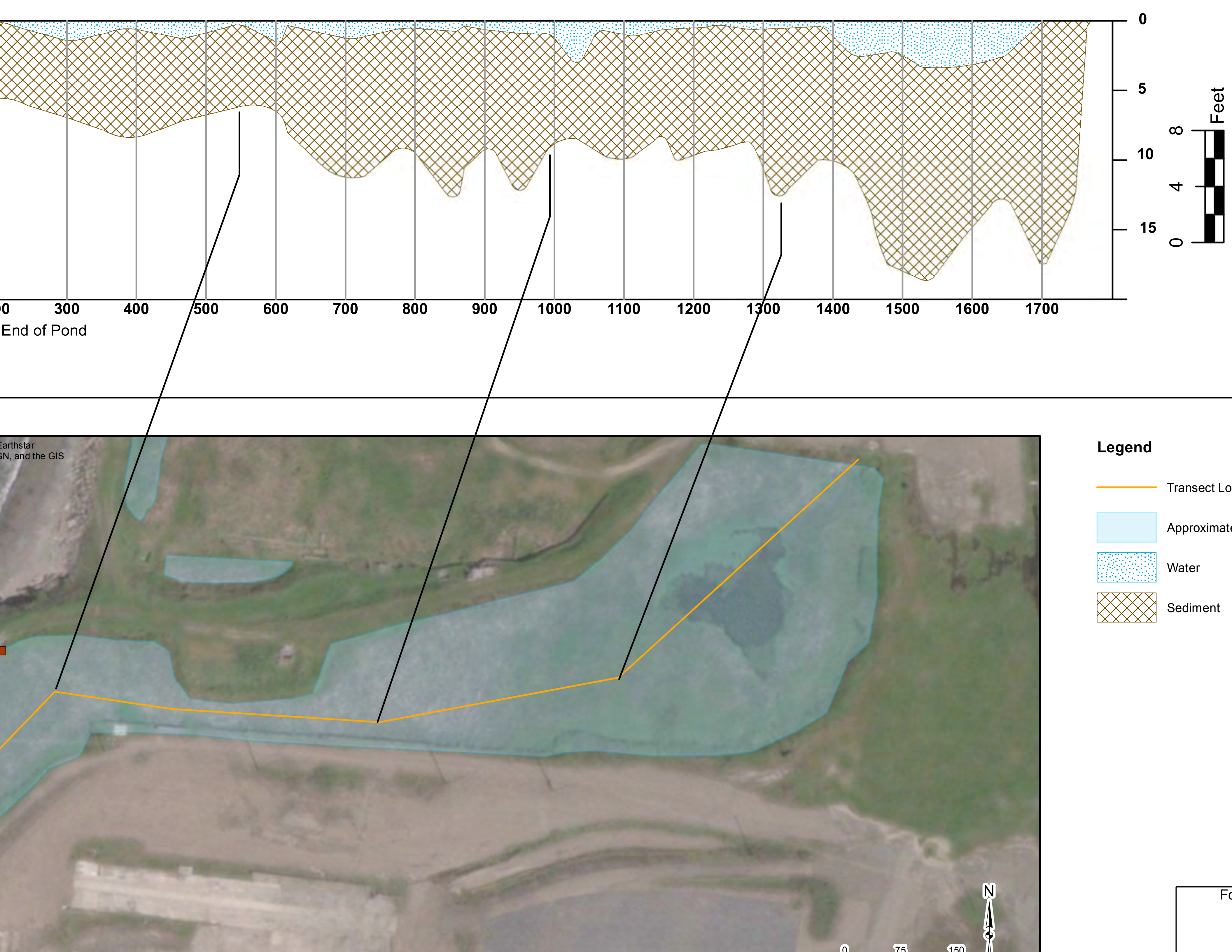
Plant Drain System Line

Former Rail Lines

N

For

Site Boundary
OU-E Boundary
Existing Structure
Pond 5 and Pond 9
Compressor House Excavation Boundary
Fuel Line Excavation Boundary
Plant Drain System Line
Sanitary Sewer Line
Unpaved Roadway
Paved Roadway
N
For



0
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8
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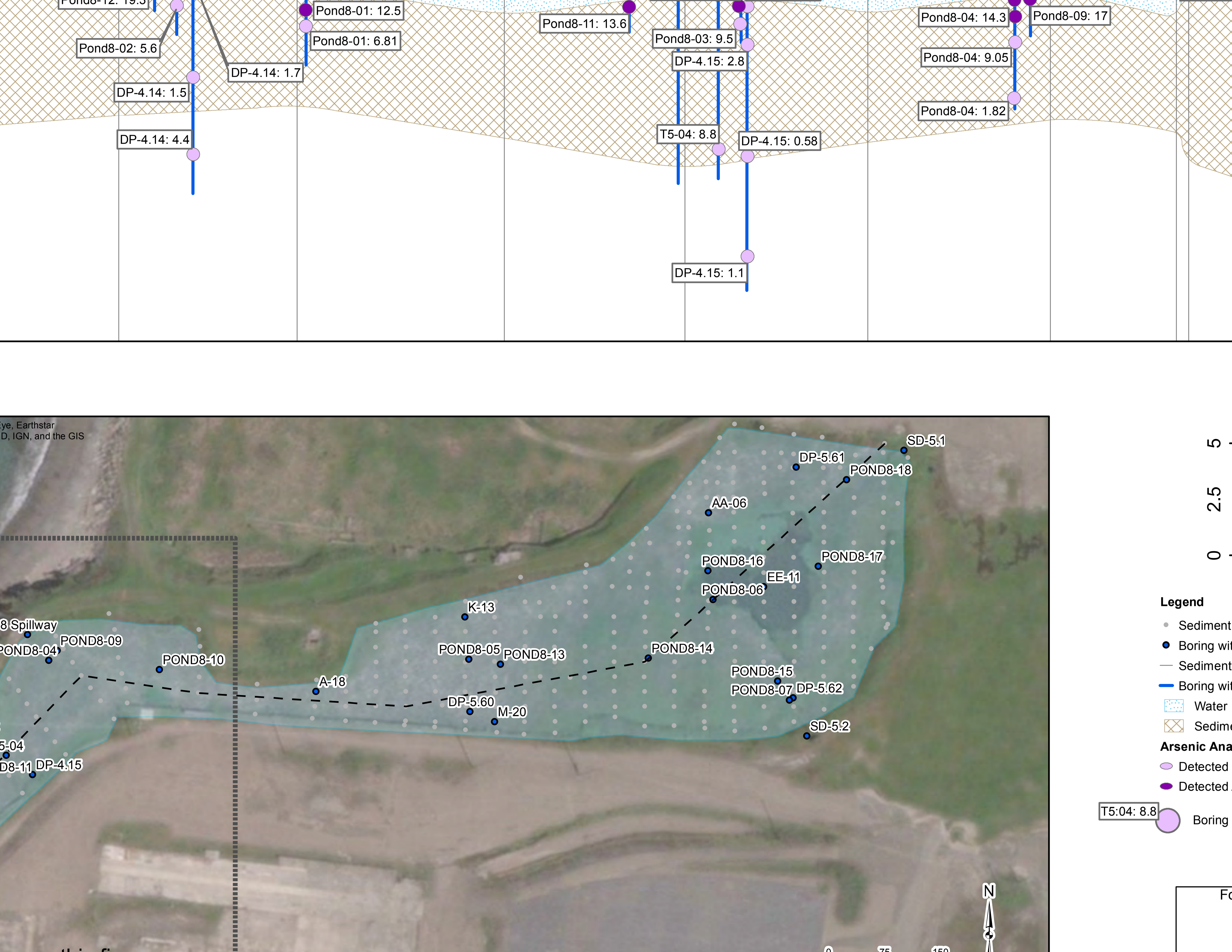
0
Feet
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
End of Pond
Earthstar
GN, and the GIS
Legend
Transect Lo
Approximat
Water
Sediment
N
0
75
150



Pond8-12: 19.3
Pond8-02: 5.6
DP-4.14: 1.5
DP-4.14: 4.4
DP-4.14: 1.7
Pond8-01: 12.5
Pond8-01: 6.81
Pond8-11: 13.6
Pond8-03: 9.5
DP-4.15: 2.8
T5-04: 8.8
DP-4.15: 0.58
DP-4.15: 1.1
Pond8-04: 14.3
Pond8-04: 9.05
Pond8-04: 1.82
Pond8-09: 17
SD-5.1
DP-5.61
POND8-18
AA-06
POND8-17
POND8-16
EE-11
POND8-06
K-13
POND8-05
POND8-13
POND8-14
POND8-15
POND8-07
DP-5.62
SD-5.2
DP-5.60
M-20
A-18
POND8-10
POND8-09
POND8-04
8 Spillway
DP-4.15
5
2.5
0
Legend
Sediment
Boring wit
Sediment
Boring wit
Water
Sedime
Arsenic Ana
Detected
Detected
T5:04: 8.8
Boring
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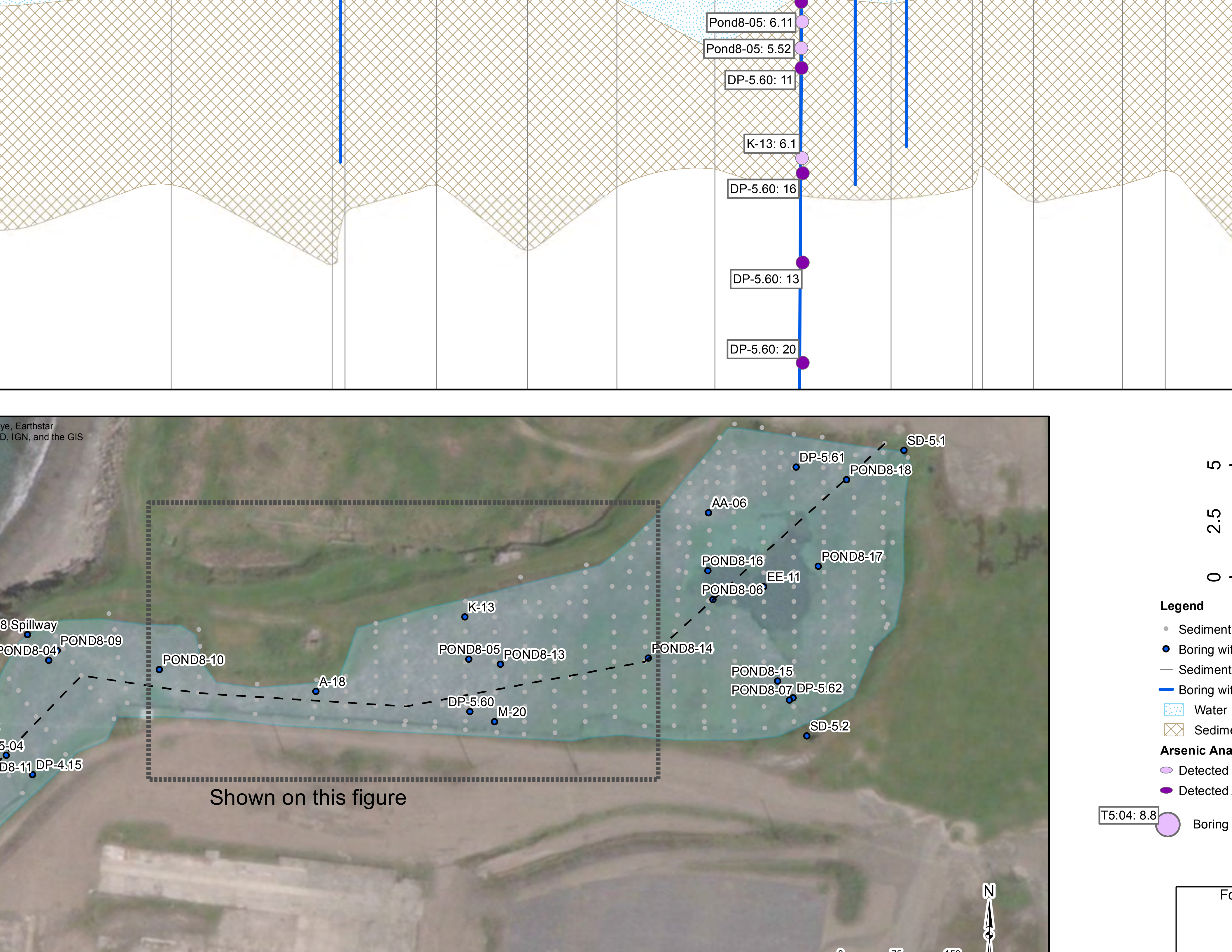
75
150



Pond8-05: 6.11
Pond8-05: 5.52
DP-5.60: 11
K-13: 6.1
DP-5.60: 16
DP-5.60: 13
DP-5.60: 20
SD-5.1
DP-5.61
POND8-18
AA-06
POND8-16
POND8-17
EE-11
POND8-06
K-13
POND8-09
POND8-10
POND8-05
POND8-13
POND8-14
POND8-15
POND8-07
DP-5.62
A-18
DP-5.60
M-20
SD-5.2
DP-4.15
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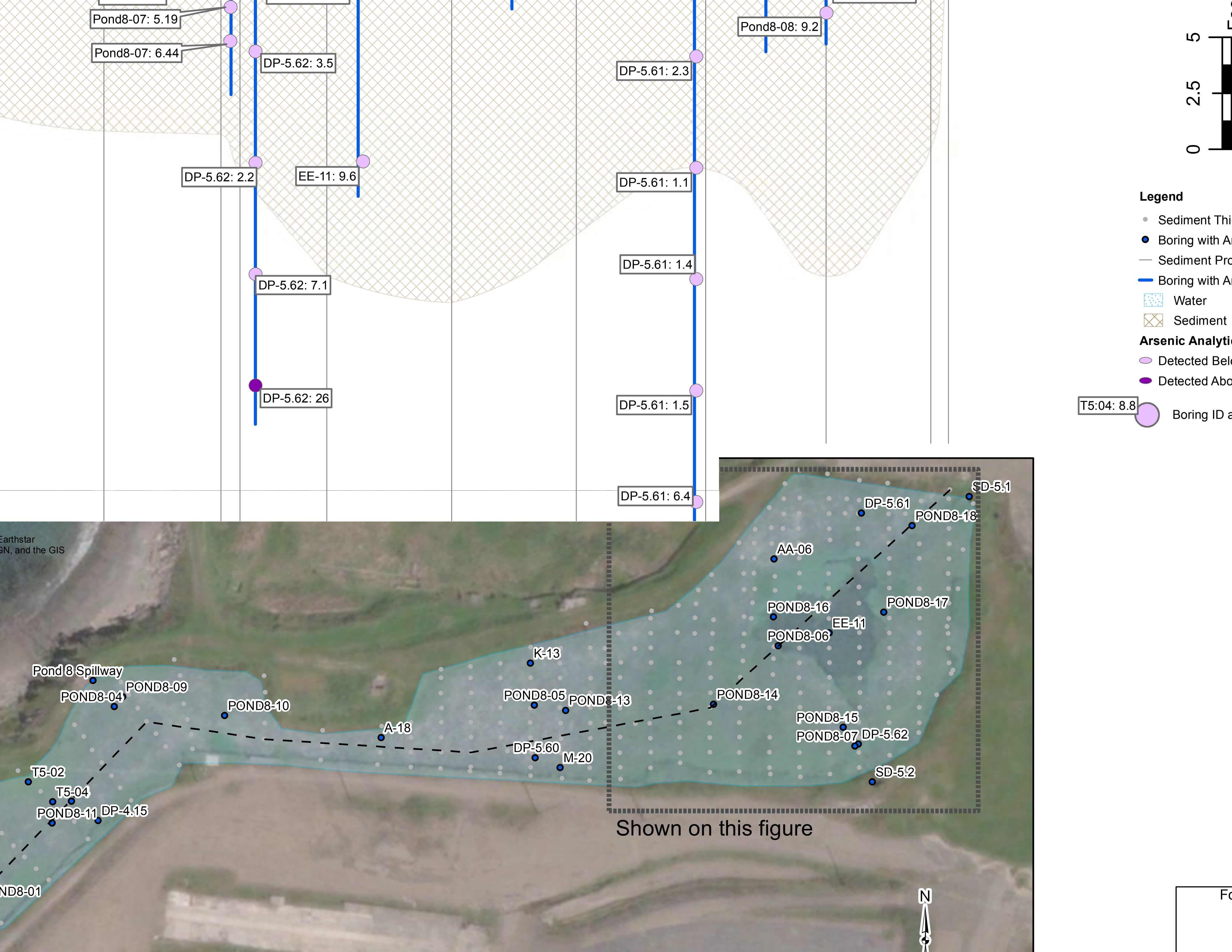
2.5
0
Legend
Water
Arsenic Ana
T5:04: 8.8
Boring



Pond8-07: 5.19
Pond8-07: 6.44
DP-5.62: 3.5
DP-5.62: 2.2
EE-11: 9.6
DP-5.62: 7.1
DP-5.62: 26
DP-5.61: 2.3
DP-5.61: 1.1
DP-5.61: 1.4
DP-5.61: 1.5
DP-5.61: 6.4
Pond8-08: 9.2
5
2.5
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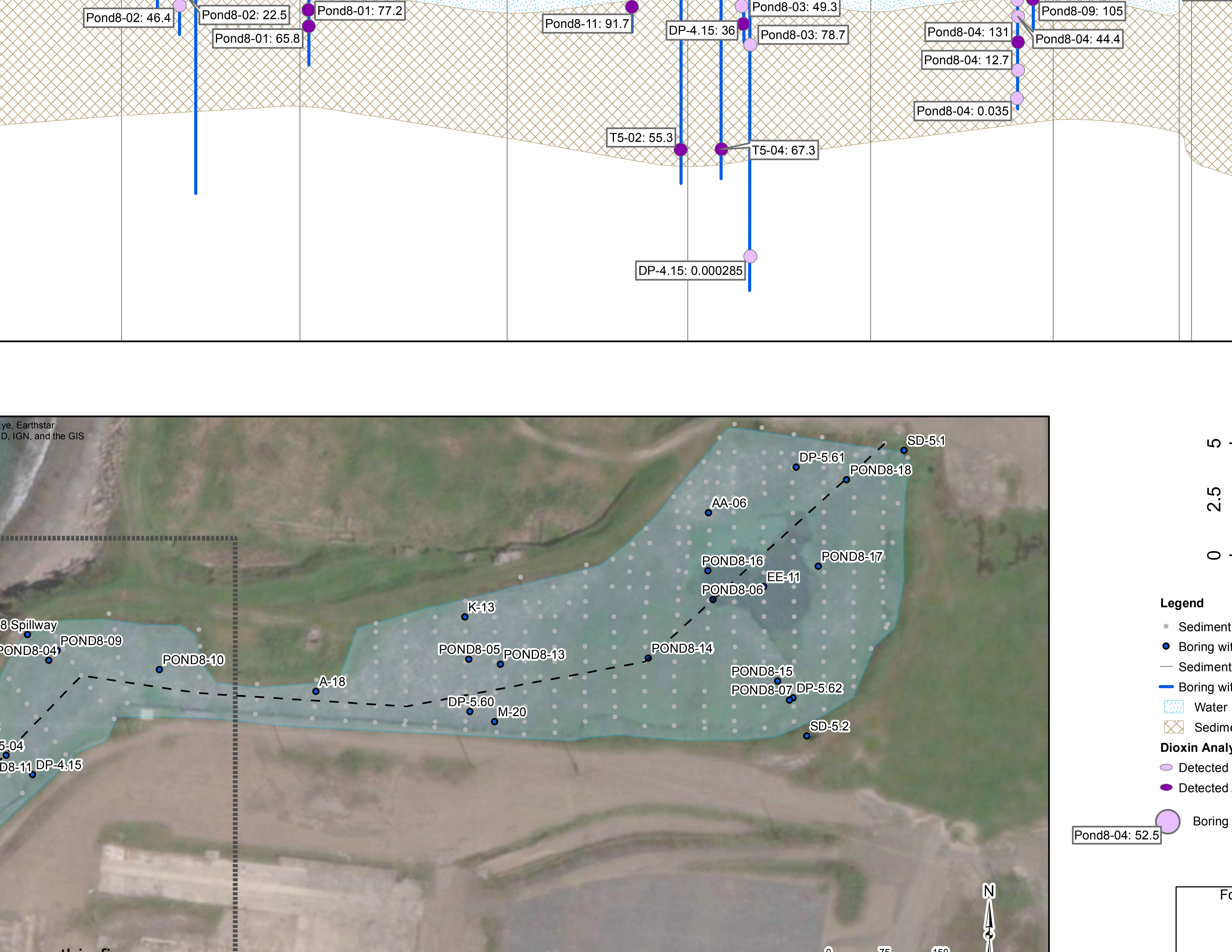
Legend
Sediment Thi
Boring with A
Sediment Pro
Boring with A
Water
Sediment
Arsenic Analyti
Detected Bel
Detected Abo
T5:04: 8.8
Boring ID a
SD-5.1
DP-5.61
POND8-18
AA-06
POND8-17
POND8-16
EE-11
POND8-06
K-13
POND8-05
POND8-13
POND8-14
POND8-15
POND8-07
DP-5.62
SD-5.2
DP-5.60
M-20
A-18
POND8-10
Pond 8 Spillway
POND8-09
POND8-04
T5-02
T5-04
POND8-11
DP-4.15
ND8-01
Shown on this figure
N
Earthstar
GN, and the GIS



Pond8-02: 46.4
Pond8-02: 22.5
Pond8-01: 77.2
Pond8-01: 65.8
Pond8-11: 91.7
DP-4.15: 36
Pond8-03: 49.3
Pond8-03: 78.7
Pond8-09: 105
Pond8-04: 131
Pond8-04: 44.4
Pond8-04: 12.7
Pond8-04: 0.035
T5-02: 55.3
T5-04: 67.3
DP-4.15: 0.000285
5
2.5
0
SD-5.1
DP-5.61
POND8-18
AA-06
POND8-17
POND8-16
EE-11
POND8-06
K-13
POND8-05
POND8-13
POND8-14
POND8-15
POND8-07
DP-5.62
SD-5.2
A-18
DP-5.60
M-20
POND8-09
POND8-10
Legend
Sediment
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Sediment
Boring wi
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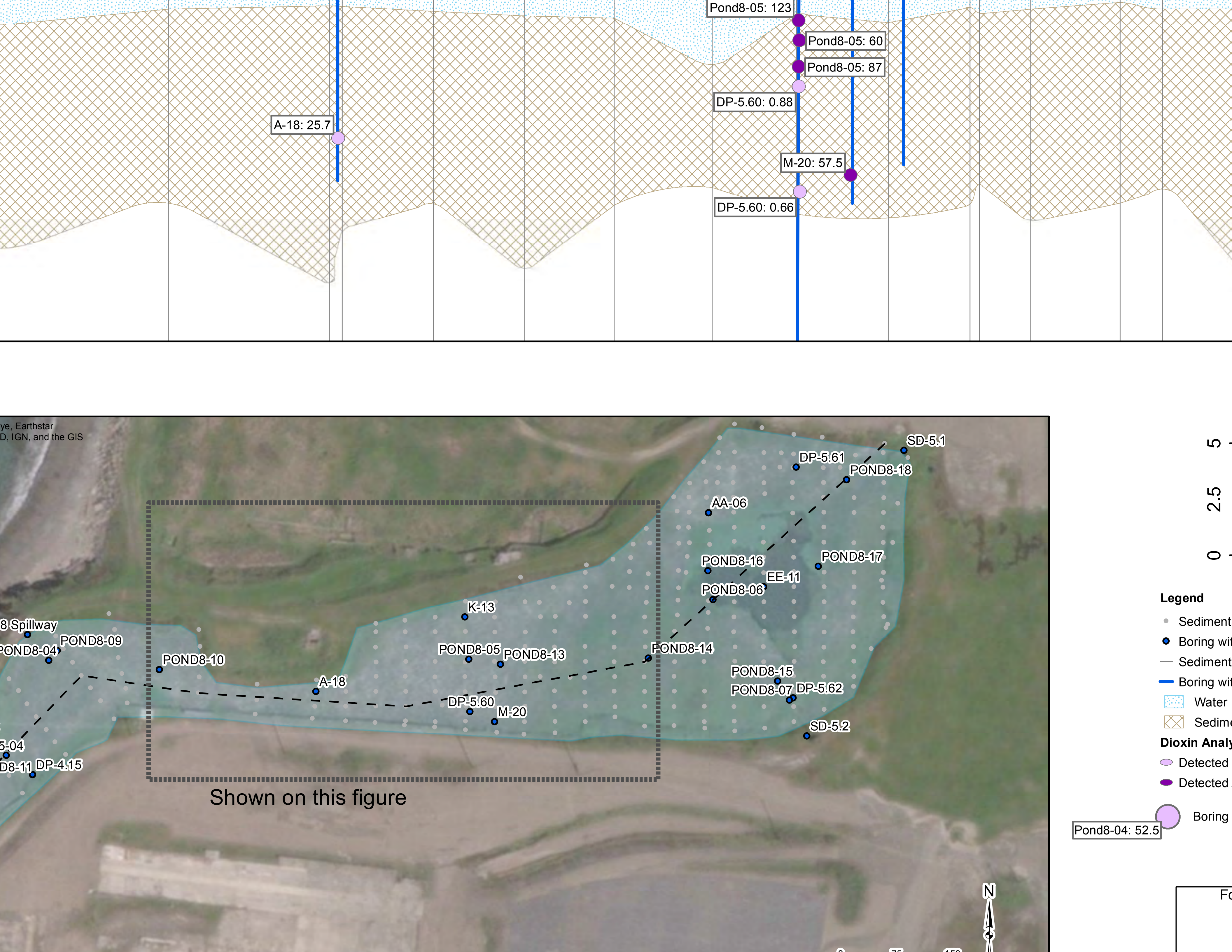
Sedime
Dioxin Analy
Detected
Detected
Pond8-04: 52.5
Boring
N



Pond8-05: 123
Pond8-05: 60
Pond8-05: 87
DP-5.60: 0.88
A-18: 25.7
M-20: 57.5
DP-5.60: 0.66
ye, Earthstar
D, IGN, and the GIS
SD-5.1
DP-5.61
POND8-18
AA-06
POND8-17
POND8-16
EE-11
POND8-06
K-13
8 Spillway
POND8-09
POND8-04
POND8-10
POND8-05
POND8-13
POND8-14
POND8-15
POND8-07
DP-5.62
A-18
DP-5.60
M-20
SD-5.2
5-04
D8-11
DP-4.15
Shown on this figure
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2.5
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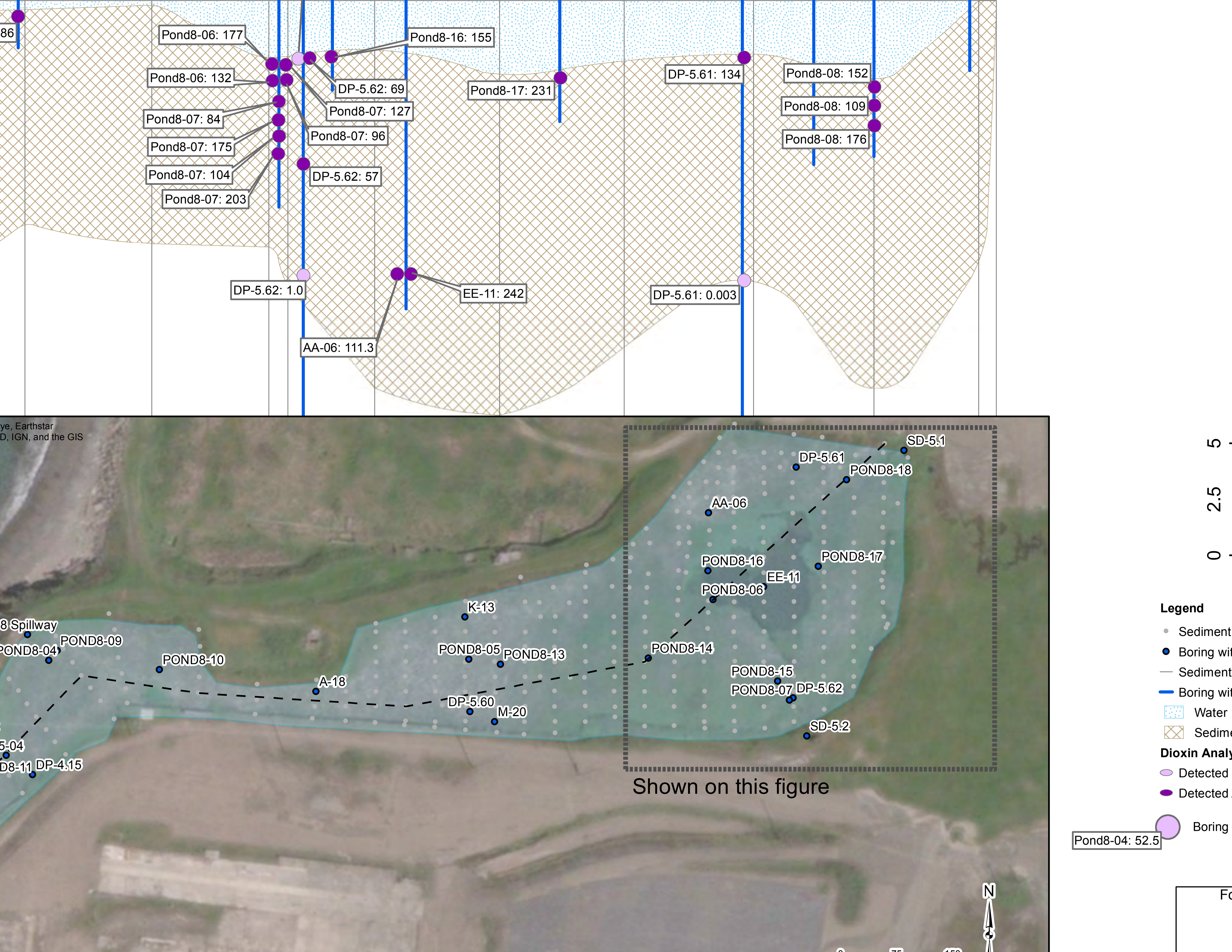
Sediment
Boring wit
Sediment
Boring wit
Water
Sedime
Dioxin Analy
Detected
Detected
Boring
Pond8-04: 52.5
Fo



86
Pond8-06: 177
Pond8-16: 155
Pond8-06: 132
DP-5.62: 69
Pond8-07: 127
Pond8-07: 84
Pond8-07: 96
Pond8-07: 175
Pond8-07: 104
DP-5.62: 57
Pond8-07: 203
Pond8-17: 231
DP-5.61: 134
Pond8-08: 152
Pond8-08: 109
Pond8-08: 176
DP-5.62: 1.0
EE-11: 242
DP-5.61: 0.003
AA-06: 111.3
ye, Earthstar
D, IGN, and the GIS
SD-5.1
DP-5.61
POND8-18
AA-06
POND8-17
POND8-16
EE-11
POND8-06
K-13
8 Spillway
POND8-09
POND8-04
POND8-10
POND8-05
POND8-13
POND8-14
A-18
POND8-15
POND8-07
DP-5.62
DP-5.60
M-20
SD-5.2
5-04
D8-11
DP-4.15
Shown on this figure
N
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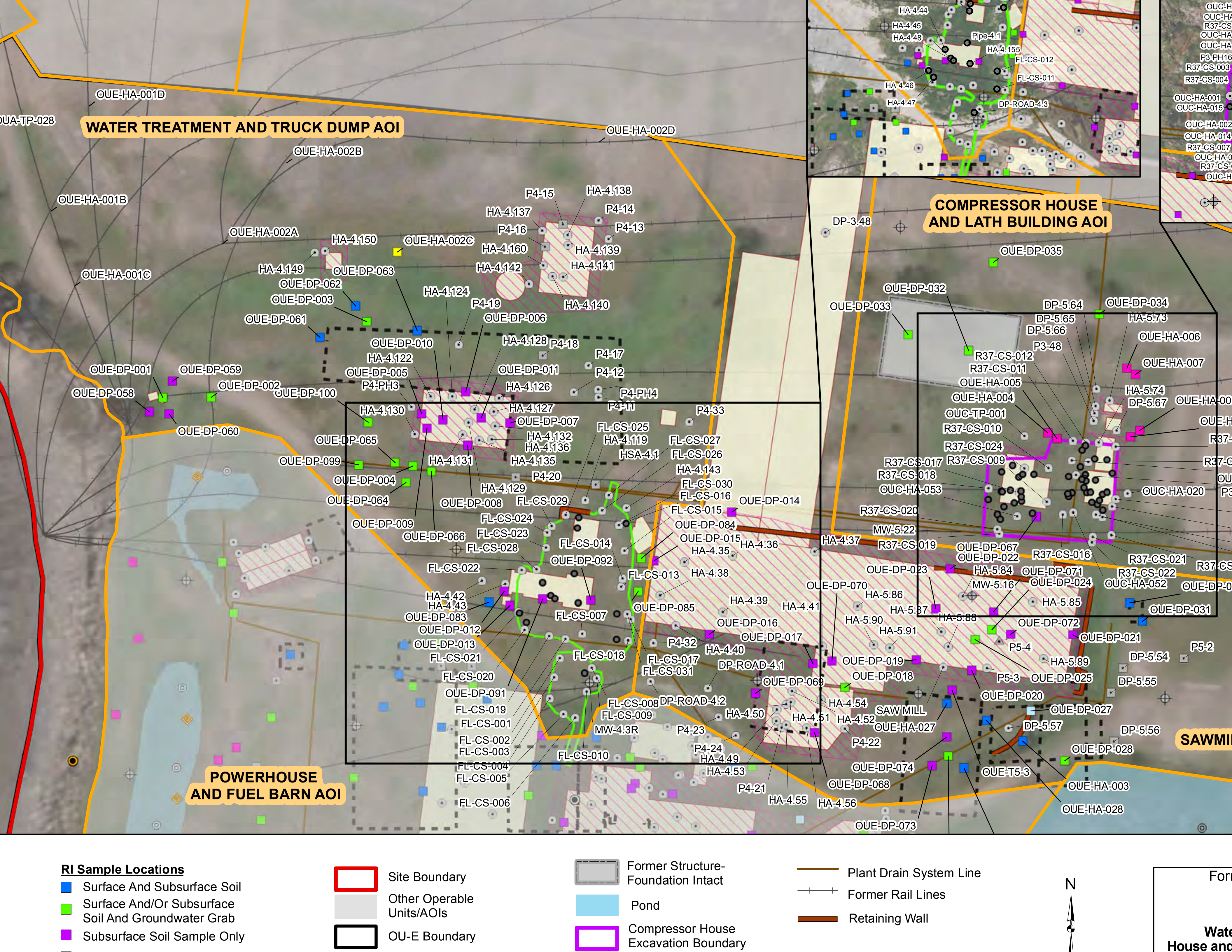
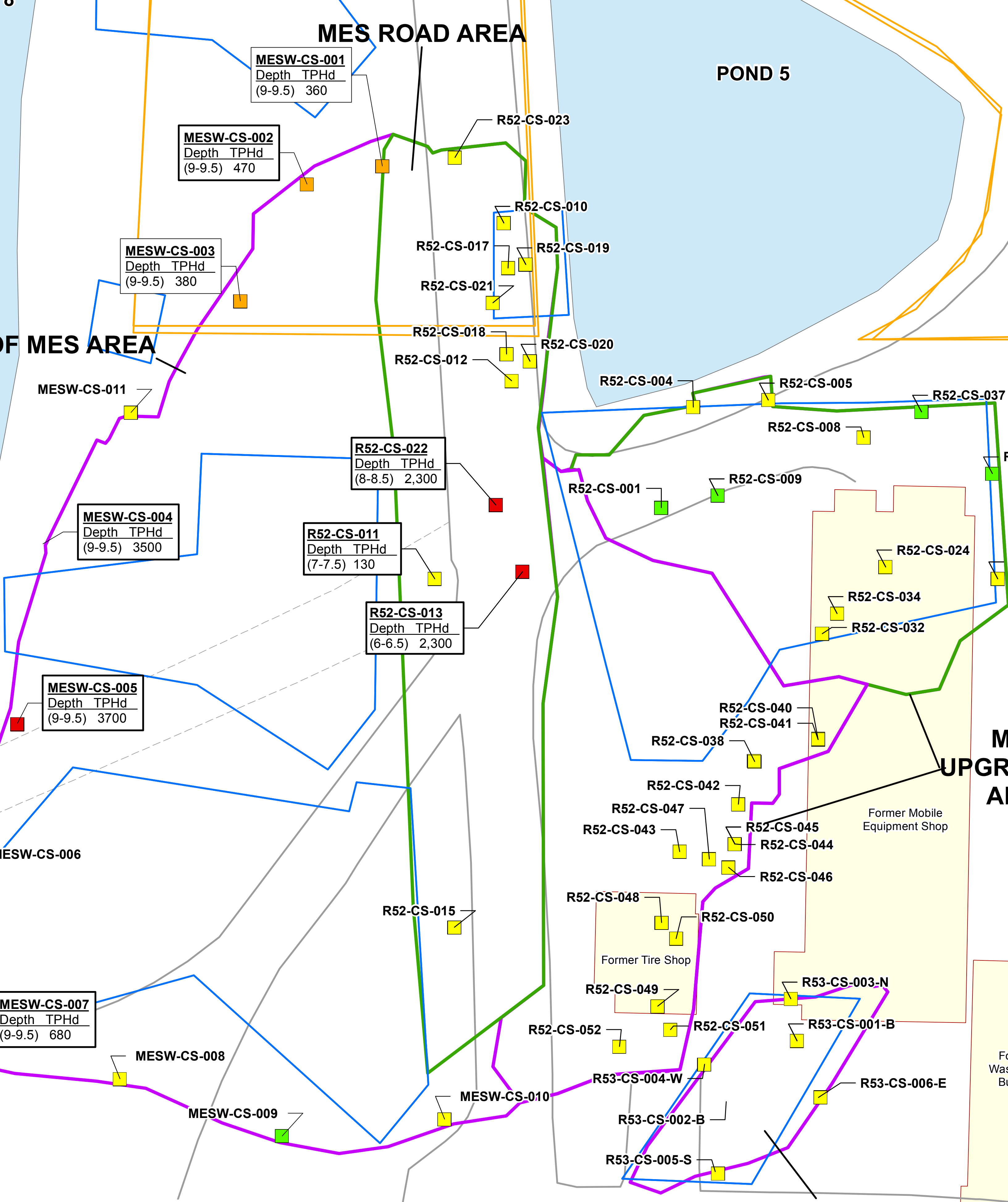
Detected
Detected
Boring
Pond8-04: 52.5
Fo



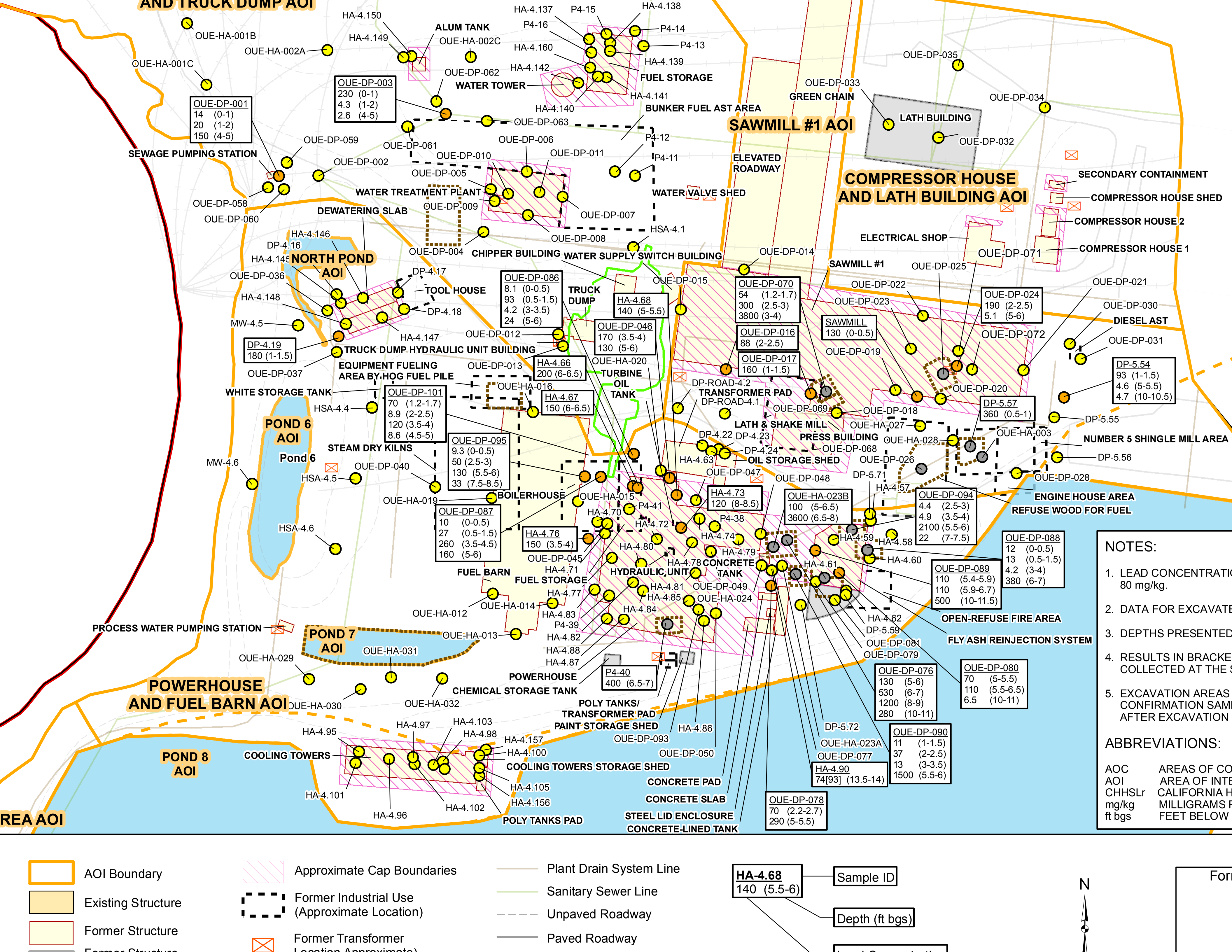
WATER TREATMENT AND TRUCK DUMP AOI
COMPRESSOR HOUSE AND LATH BUILDING AOI
POWERHOUSE AND FUEL BARN AOI
SAWMILL
RI Sample Locations
Surface And Subsurface Soil
Surface And/Or Subsurface Soil And Groundwater Grab
Subsurface Soil Sample Only
Site Boundary
Other Operable Units/AOIs
OU-E Boundary
Former Structure-Foundation Intact
Pond
Compressor House Excavation Boundary
Plant Drain System Line
Former Rail Lines
Retaining Wall
N



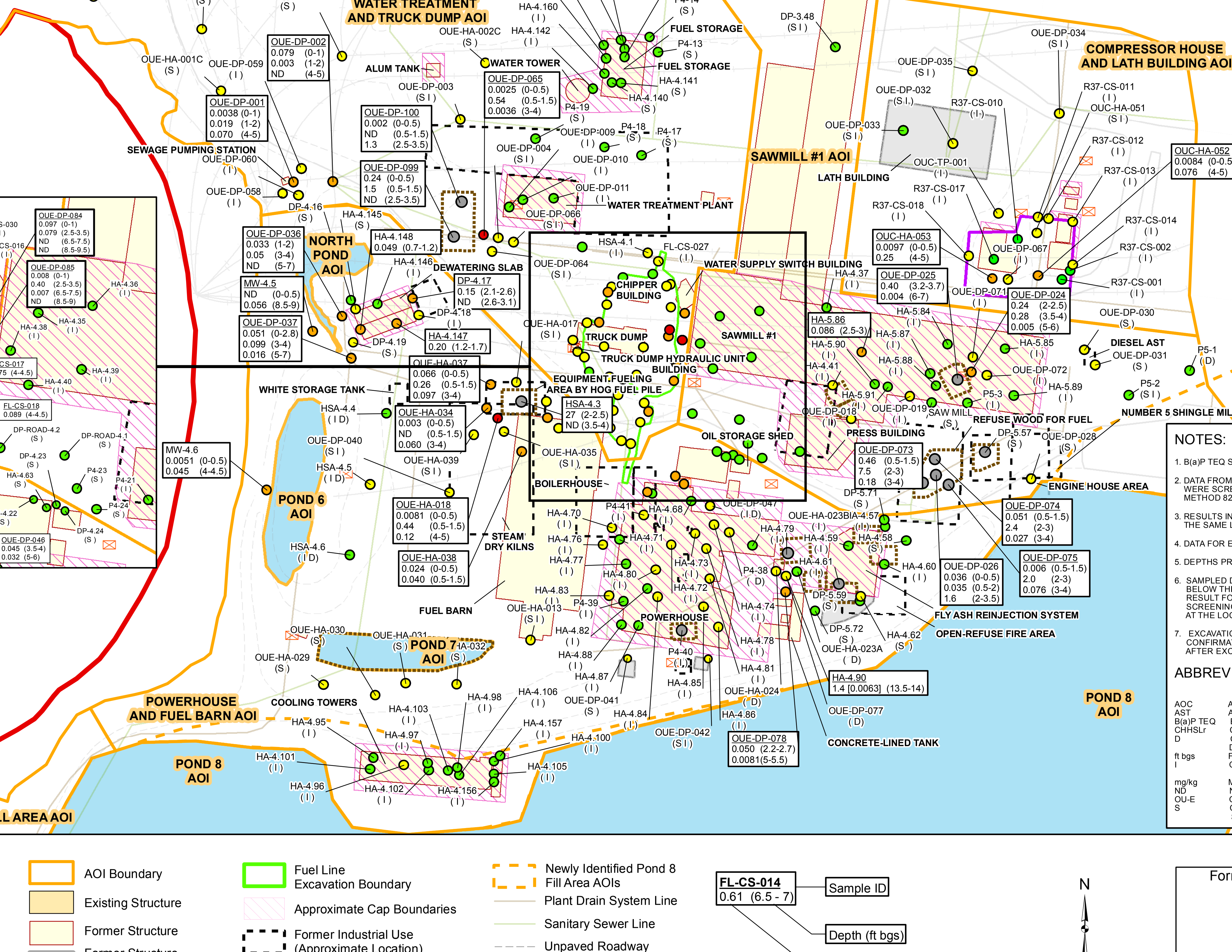
ETROLEUM HYDROCARBONS AS DIESEL.
TRATIONS ARE IN mg/kg (MILLIGRAMS PER KILOGRAM).

NCENTRATIONS SCREENED AGAINST HIGHEST
ANCE OF RBSCs FOR THEIR RESPECTIVE FRACTIONS:
30 mg/kg; C12-C16: 90mg/kg; C16-C24: 191 mg/kg.

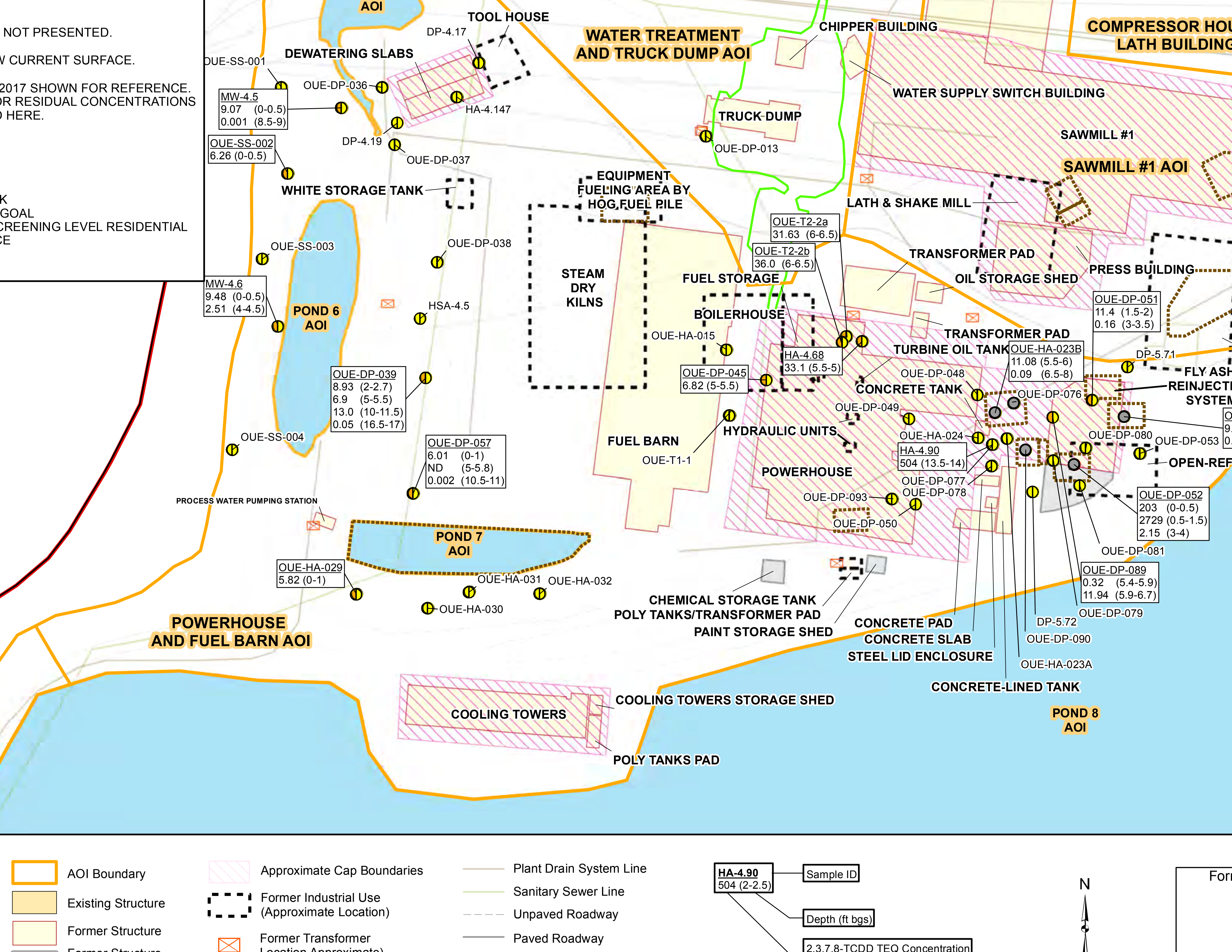
XES PRESENT C16-C24 SAMPLE CONCENTRATIONS



AND TRUCK DUMP AOI
SAWMILL #1 AOI
COMPRESSOR HOUSE AND LATH BUILDING AOI
NORTH POND AOI
POND 6 AOI
POND 7 AOI
POND 8 AOI
POWERHOUSE AND FUEL BARN AOI
REA AOI
ALUM TANK
WATER TOWER
FUEL STORAGE
BUNKER FUEL AST AREA
GREEN CHAIN
LATH BUILDING
ELEVATED ROADWAY
SECONDARY CONTAINMENT
COMPRESSOR HOUSE SHED
COMPRESSOR HOUSE 2
COMPRESSOR HOUSE 1
ELECTRICAL SHOP
SAWMILL #1
SEWAGE PUMPING STATION
WATER TREATMENT PLANT
DEWATERING SLAB
WATER VALVE SHED
CHIPPER BUILDING
WATER SUPPLY SWITCH BUILDING
TOOL HOUSE
TRUCK DUMP
TRUCK DUMP HYDRAULIC UNIT BUILDING
EQUIPMENT FUELING AREA BY HOG FUEL PILE
WHITE STORAGE TANK
TURBINE OIL TANK
TRANSFORMER PAD
LATH & SHAKE MILL
PRESS BUILDING
OIL STORAGE SHED
STEAM DRY KILNS
BOILERHOUSE
FUEL BARN
FUEL STORAGE
HYDRAULIC UNIT
CONCRETE TANK
DIESEL AST
NUMBER 5 SHINGLE MILL AREA
ENGINE HOUSE AREA
REFUSE WOOD FOR FUEL
OPEN-REFUSE FIRE AREA
FLY ASH REINJECTION SYSTEM
PROCESS WATER PUMPING STATION
POWERHOUSE
CHEMICAL STORAGE TANK
POLY TANKS/ TRANSFORMER PAD
PAINT STORAGE SHED
COOLING TOWERS
COOLING TOWERS STORAGE SHED
CONCRETE PAD
CONCRETE SLAB
STEEL LID ENCLOSURE
CONCRETE-LINED TANK
POLY TANKS PAD
Pond 6
OUE-DP-001 14 (0-1) 20 (1-2) 150 (4-5)
OUE-DP-003 230 (0-1) 4.3 (1-2) 2.6 (4-5)
DP-4.19 180 (1-1.5)
OUE-DP-086 8.1 (0-0.5) 93 (0.5-1.5) 4.2 (3-3.5) 24 (5-6)
HA-4.68 140 (5-5.5)
OUE-DP-046 170 (3.5-4) 130 (5-6)
HA-4.66 200 (6-6.5)
HA-4.67 150 (6-6.5)
OUE-DP-101 70 (1.2-1.7) 8.9 (2-2.5) 120 (3.5-4) 8.6 (4.5-5)
OUE-DP-095 9.3 (0-0.5) 50 (2.5-3) 130 (5.5-6) 33 (7.5-8.5)
OUE-DP-087 10 (0-0.5) 27 (0.5-1.5) 260 (3.5-4.5) 160 (5-6)
HA-4.76 150 (3.5-4)
OUE-DP-070 54 (1.2-1.7) 300 (2.5-3) 3800 (3-4)
OUE-DP-016 88 (2-2.5)
OUE-DP-017 160 (1-1.5)
SAWMILL 130 (0-0.5)
OUE-DP-024 190 (2-2.5) 5.1 (5-6)
DP-5.57 360 (0.5-1)
DP-5.54 93 (1-1.5) 4.6 (5-5.5) 4.7 (10-10.5)
HA-4.73 120 (8-8.5)
OUE-HA-023B 100 (5-6.5) 3600 (6.5-8)
OUE-DP-094 4.4 (2.5-3) 4.9 (3.5-4) 2100 (5.5-6) 22 (7-7.5)
OUE-DP-088 12 (0-0.5) 13 (0.5-1.5) 4.2 (3-4) 380 (6-7)
OUE-DP-089 110 (5.4-5.9) 110 (5.9-6.7) 500 (10-11.5)
OUE-DP-080 70 (5-5.5) 110 (5.5-6.5) 6.5 (10-11)
OUE-DP-076 130 (5-6) 530 (6-7) 1200 (8-9) 280 (10-11)
OUE-DP-090 11 (1-1.5) 37 (2-2.5) 13 (3-3.5) 1500 (5.5-6)
HA-4.90 74[93] (13.5-14)
OUE-DP-078 70 (2.2-2.7) 290 (5-5.5)
P4-40 400 (6.5-7)
NOTES:
1. LEAD CONCENTRATI
80 mg/kg.
2. DATA FOR EXCAVATE
3. DEPTHS PRESENTED
4. RESULTS IN BRACKE
COLLECTED AT THE S
5. EXCAVATION AREAS
CONFIRMATION SAMI
AFTER EXCAVATION
ABBREVIATIONS:
AOC AREAS OF CO
AOI AREA OF INTE
CHHSLr CALIFORNIA H
mg/kg MILLIGRAMS P
ft bgs FEET BELOW
AOI Boundary
Existing Structure
Former Structure
Approximate Cap Boundaries
Former Industrial Use (Approximate Location)
Former Transformer Location Approximate)
Plant Drain System Line
Sanitary Sewer Line
Unpaved Roadway
Paved Roadway
HA-4.68 140 (5.5-6)
Sample ID
Depth (ft bgs)
N



WATER TREATMENT AND TRUCK DUMP AOI
COMPRESSOR HOUSE AND LATH BUILDING AOI
SAWMILL #1 AOI
NORTH POND AOI
POND 6 AOI
POND 7 AOI
POND 8 AOI
POWERHOUSE AND FUEL BARN AOI
SEWAGE PUMPING STATION
ALUM TANK
WATER TOWER
FUEL STORAGE
WATER TREATMENT PLANT
LATH BUILDING
DEWATERING SLAB
WATER SUPPLY SWITCH BUILDING
CHIPPER BUILDING
TRUCK DUMP
TRUCK DUMP HYDRAULIC UNIT BUILDING
SAWMILL #1
EQUIPMENT FUELING AREA BY HOG FUEL PILE
WHITE STORAGE TANK
OIL STORAGE SHED
PRESS BUILDING
REFUSE WOOD FOR FUEL
SAW MILL
DIESEL AST
NUMBER 5 SHINGLE MIL
ENGINE HOUSE AREA
BOILERHOUSE
STEAM DRY KILNS
FUEL BARN
POWERHOUSE
FLY ASH REINJECTION SYSTEM
OPEN-REFUSE FIRE AREA
CONCRETE-LINED TANK
COOLING TOWERS
NOTES:
ABBREV
AOI Boundary
Existing Structure
Former Structure
Fuel Line Excavation Boundary
Approximate Cap Boundaries
Former Industrial Use (Approximate Location)
Newly Identified Pond 8 Fill Area AOIs
Plant Drain System Line
Sanitary Sewer Line
Unpaved Roadway
FL-CS-014
0.61 (6.5 - 7)
Sample ID
Depth (ft bgs)
N


NOT PRESENTED.
W CURRENT SURFACE.
2017 SHOWN FOR REFERENCE.
OR RESIDUAL CONCENTRATIONS
D HERE.
K
GOAL
CREENING LEVEL RESIDENTIAL
CE
WATER TREATMENT AND TRUCK DUMP AOI
COMPRESSOR HOU
LATH BUILDING
TOOL HOUSE
CHIPPER BUILDING
DEWATERING SLABS
WATER SUPPLY SWITCH BUILDING
TRUCK DUMP
SAWMILL #1
SAWMILL #1 AOI
WHITE STORAGE TANK
EQUIPMENT FUELING AREA BY HOG FUEL PILE
LATH & SHAKE MILL
TRANSFORMER PAD
PRESS BUILDING
OIL STORAGE SHED
STEAM DRY KILNS
FUEL STORAGE
BOILERHOUSE
TRANSFORMER PAD
TURBINE OIL TANK
CONCRETE TANK
FLY ASH REINJECTI SYSTEM
HYDRAULIC UNITS
POWERHOUSE
FUEL BARN
OPEN-REF
POND 6 AOI
POND 7 AOI
POND 8 AOI
PROCESS WATER PUMPING STATION
POWERHOUSE AND FUEL BARN AOI
CHEMICAL STORAGE TANK
POLY TANKS/TRANSFORMER PAD
PAINT STORAGE SHED
CONCRETE PAD
CONCRETE SLAB
STEEL LID ENCLOSURE
CONCRETE-LINED TANK
COOLING TOWERS
COOLING TOWERS STORAGE SHED
POLY TANKS PAD
AOI
OUE-SS-001
MW-4.5
9.07 (0-0.5)
0.001 (8.5-9)
OUE-SS-002
6.26 (0-0.5)
OUE-DP-036
DP-4.17
HA-4.147
DP-4.19
OUE-DP-037
OUE-DP-013
OUE-SS-003
OUE-DP-038
MW-4.6
9.48 (0-0.5)
2.51 (4-4.5)
HSA-4.5
OUE-DP-039
8.93 (2-2.7)
6.9 (5-5.5)
13.0 (10-11.5)
0.05 (16.5-17)
OUE-SS-004
OUE-DP-057
6.01 (0-1)
ND (5-5.8)
0.002 (10.5-11)
OUE-HA-029
5.82 (0-1)
OUE-HA-031
OUE-HA-032
OUE-HA-030
OUE-T2-2a
31.63 (6-6.5)
OUE-T2-2b
36.0 (6-6.5)
OUE-HA-015
HA-4.68
33.1 (5.5-5)
OUE-DP-045
6.82 (5-5.5)
OUE-T1-1
OUE-DP-051
11.4 (1.5-2)
0.16 (3-3.5)
DP-5.71
OUE-HA-023B
11.08 (5.5-6)
0.09 (6.5-8)
OUE-DP-048
OUE-DP-076
OUE-DP-049
OUE-HA-024
HA-4.90
504 (13.5-14)
OUE-DP-080
OUE-DP-053
OUE-DP-077
OUE-DP-078
OUE-DP-093
OUE-DP-050
OUE-DP-052
203 (0-0.5)
2729 (0.5-1.5)
2.15 (3-4)
OUE-DP-081
OUE-DP-089
0.32 (5.4-5.9)
11.94 (5.9-6.7)
OUE-DP-079
DP-5.72
OUE-DP-090
OUE-HA-023A
AOI Boundary
Existing Structure
Former Structure
Approximate Cap Boundaries
Former Industrial Use (Approximate Location)
Former Transformer Location Approximate)
Plant Drain System Line
Sanitary Sewer Line
Unpaved Roadway
Paved Roadway
HA-4.90
504 (2-2.5)
Sample ID
Depth (ft bgs)
2,3,7,8-TCDD TEQ Concentration
N
For

ATION OF 10 mg/kg FOR SEDIMENT.

C IN SEDIMENT (9.76 mg/kg)
BACKGROUND VALUE FOR
WAS SELECTED AS THE PSL FOR

E NOT PRESENTED.

W CURRENT SURFACE.

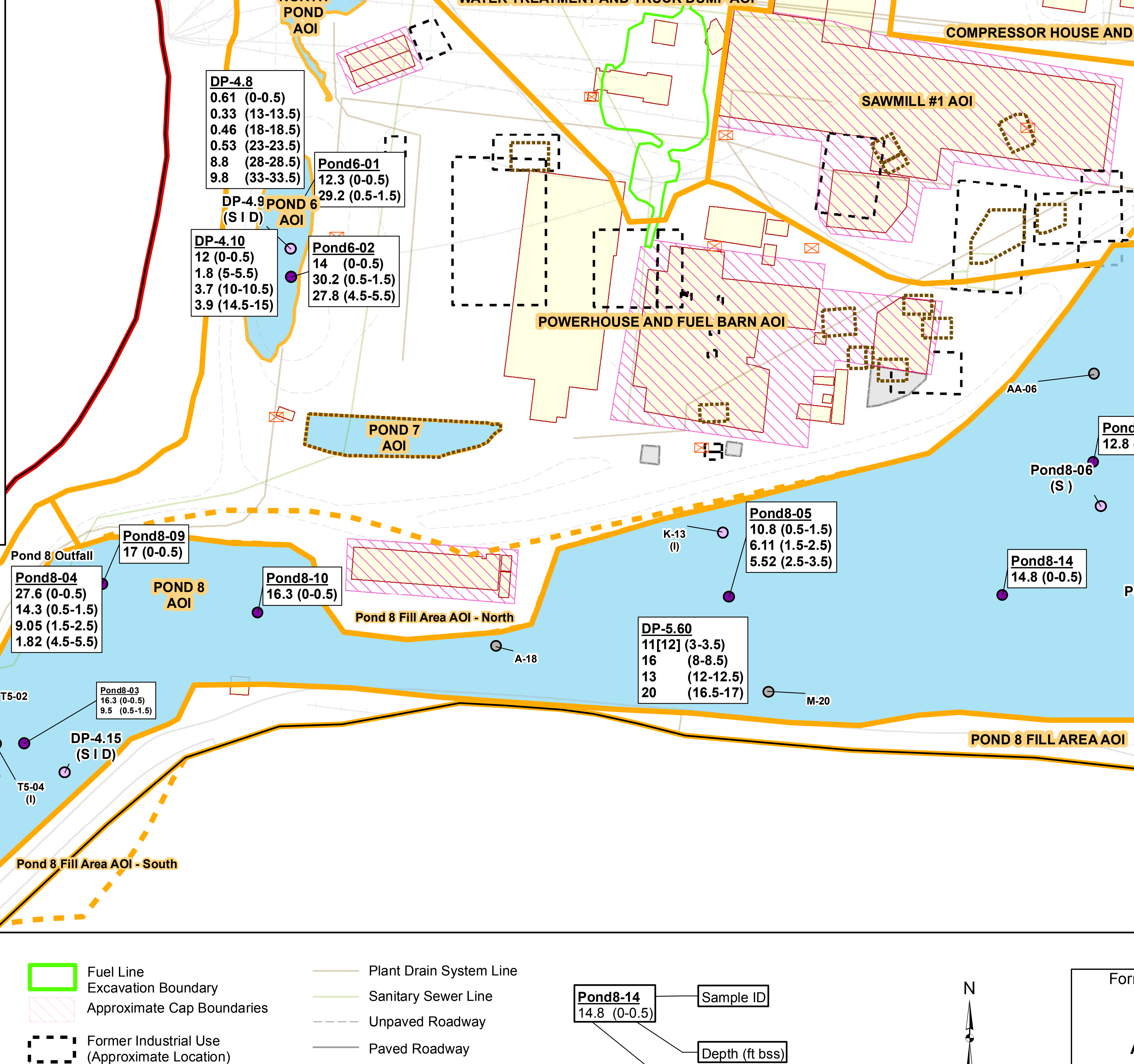
NDICATED IN PARENTHESES
or "D". THE SCREENING
SED ON THE HIGHEST
F ALL SAMPLES COLLECTED

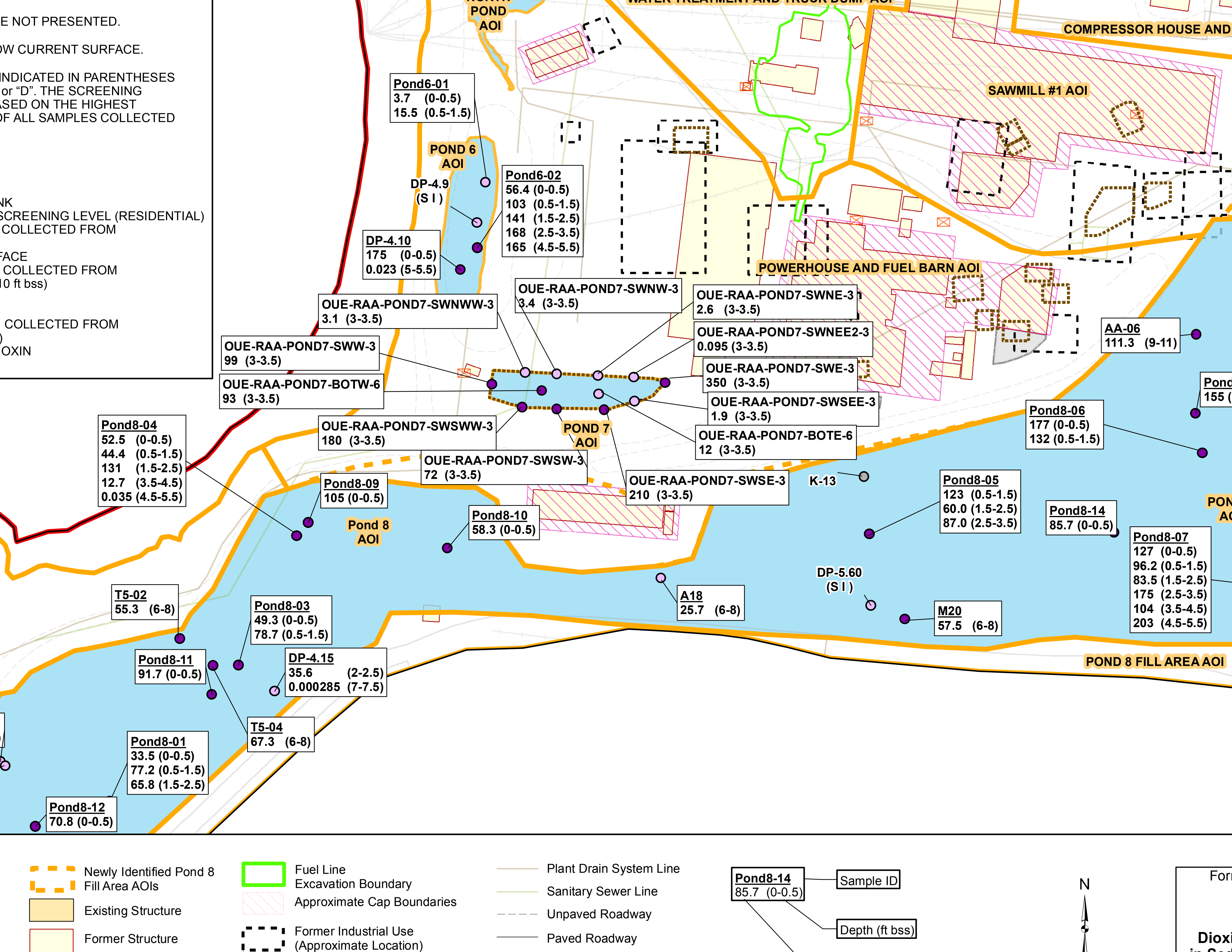
A DUPLICATE SAMPLE COLLECTED
RENT SAMPLE.

ANK
S COLLECTED FROM

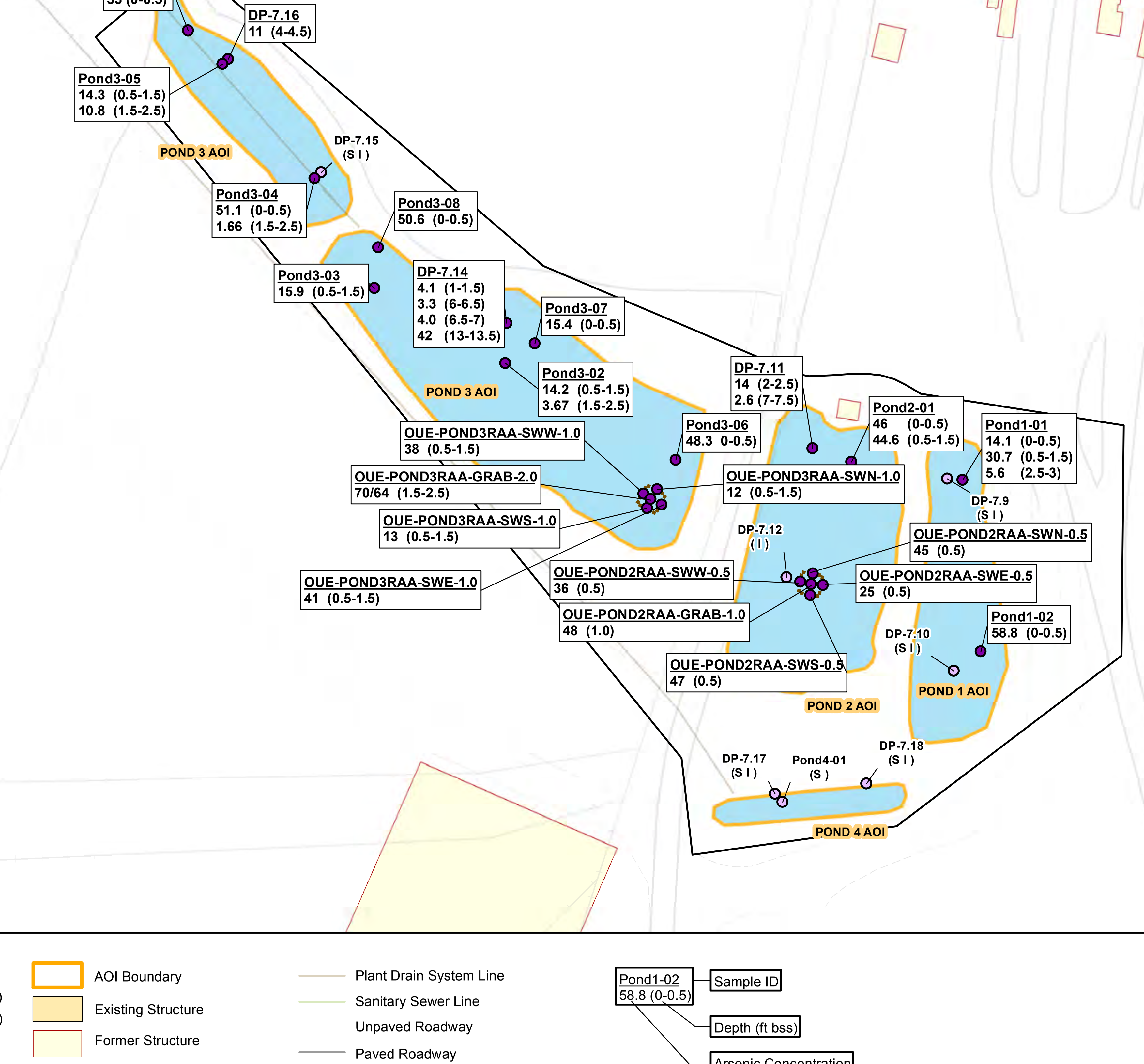
RFACE
S COLLECTED FROM
2-10 ft bss)

S COLLECTED FROM
s)
ENTRATION





E NOT PRESENTED.
OW CURRENT SURFACE.
INDICATED IN PARENTHESES
or "D". THE SCREENING
ASED ON THE HIGHEST
OF ALL SAMPLES COLLECTED
NK
SCREENING LEVEL (RESIDENTIAL)
COLLECTED FROM
FACE
COLLECTED FROM
10 ft bss)
COLLECTED FROM
OXIN
POND AOI
WATER TREATMENT AND TRUCK DUMP AOI
COMPRESSOR HOUSE AND
SAWMILL #1 AOI
POWERHOUSE AND FUEL BARN AOI
POND 6 AOI
POND 7 AOI
Pond 8 AOI
POND 8 FILL AREA AOI
Pond6-01 3.7 (0-0.5) 15.5 (0.5-1.5)
DP-4.9 (S I)
Pond6-02 56.4 (0-0.5) 103 (0.5-1.5) 141 (1.5-2.5) 168 (2.5-3.5) 165 (4.5-5.5)
DP-4.10 175 (0-0.5) 0.023 (5-5.5)
OUE-RAA-POND7-SWNWW-3 3.1 (3-3.5)
OUE-RAA-POND7-SWNW-3 3.4 (3-3.5)
OUE-RAA-POND7-SWNE-3 2.6 (3-3.5)
OUE-RAA-POND7-SWNEE2-3 0.095 (3-3.5)
OUE-RAA-POND7-SWE-3 350 (3-3.5)
OUE-RAA-POND7-SWSEE-3 1.9 (3-3.5)
OUE-RAA-POND7-BOTE-6 12 (3-3.5)
OUE-RAA-POND7-SWW-3 99 (3-3.5)
OUE-RAA-POND7-BOTW-6 93 (3-3.5)
OUE-RAA-POND7-SWSWW-3 180 (3-3.5)
OUE-RAA-POND7-SWSW-3 72 (3-3.5)
OUE-RAA-POND7-SWSE-3 210 (3-3.5)
AA-06 111.3 (9-11)
Pond 155 (
Pond8-06 177 (0-0.5) 132 (0.5-1.5)
K-13
Pond8-05 123 (0.5-1.5) 60.0 (1.5-2.5) 87.0 (2.5-3.5)
Pond8-14 85.7 (0-0.5)
PON AO
Pond8-07 127 (0-0.5) 96.2 (0.5-1.5) 83.5 (1.5-2.5) 175 (2.5-3.5) 104 (3.5-4.5) 203 (4.5-5.5)
Pond8-04 52.5 (0-0.5) 44.4 (0.5-1.5) 131 (1.5-2.5) 12.7 (3.5-4.5) 0.035 (4.5-5.5)
Pond8-09 105 (0-0.5)
Pond8-10 58.3 (0-0.5)
DP-5.60 (S I)
A18 25.7 (6-8)
M20 57.5 (6-8)
T5-02 55.3 (6-8)
Pond8-03 49.3 (0-0.5) 78.7 (0.5-1.5)
Pond8-11 91.7 (0-0.5)
DP-4.15 35.6 (2-2.5) 0.000285 (7-7.5)
T5-04 67.3 (6-8)
Pond8-01 33.5 (0-0.5) 77.2 (0.5-1.5) 65.8 (1.5-2.5)
Pond8-12 70.8 (0-0.5)
Newly Identified Pond 8 Fill Area AOIs
Existing Structure
Former Structure
Fuel Line Excavation Boundary
Approximate Cap Boundaries
Former Industrial Use (Approximate Location)
Plant Drain System Line
Sanitary Sewer Line
Unpaved Roadway
Paved Roadway
Pond8-14 85.7 (0-0.5)
Sample ID
Depth (ft bss)
N
For
Dioxi



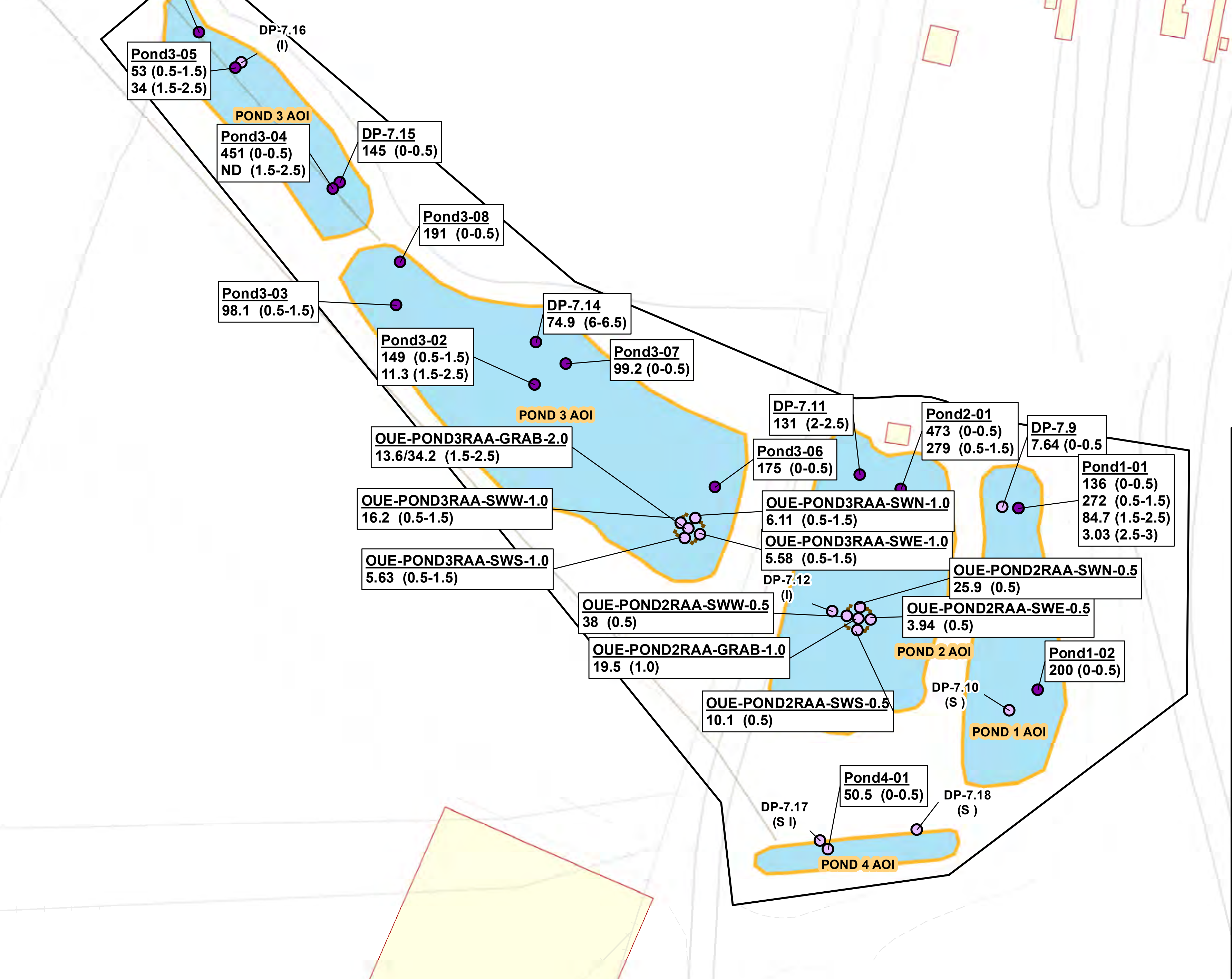
NOTES:

1. ARSENIC CONCENTRATIONS BACKGROUND CONCENTRAT
2. THE ECOLOGICAL PSL FOR A IS APPROXIMATELY EQUAL T ARSENIC IN SOIL (10 mg/kg) W HUMAN HEALTH.
3. DATA FOR EXCAVATED SAMP
4. DEPTHS PRESENTED AS FEE
5. SAMPLED DEPTH INTERVAL(BELOW THE LOCATION ID AS RESULT FOR EACH LOCATIO SCREENING LEVEL EXCEEDA AT THE LOCATION.

ABBREVIATIONS:

AOI	AREA OF INTEREST
D	ONE OR MORE SOIL S DEEP INTERVAL (>10
ft bss	FEET BELOW SEDIME
I	ONE OR MORE SOIL S INTERMEDIATE INTER
mg/kg	MILLIGRAM PER KILO
OU-E	OPERABLE UNIT E
S	ONE OR MORE SOIL S SHALLOW INTERVAL (
TEC	THRESHOLD EFFECTS

For



NOTES:

1. 2,3,7,8-TCDD TEQ (HUMAN/M
SCREENED AGAINST DRAFT
53 pg/g FOR SEDIMENT.
2. DATA FOR EXCAVATED SAM
3. DEPTHS PRESENTED AS FE
4. SAMPLED DEPTH INTERVA
BELOW THE LOCATION ID A
RESULT FOR EACH LOCATIO
SCREENING LEVEL EXCEED
AT THE LOCATION.

ABBREVIATIONS:

AOI	AREA OF INTEREST
AST	ABOVEGROUND STOR
CHHSLr	CALIFORNIA HUMAN H
D	ONE OR MORE SOIL S DEEP INTERVAL (>10 f
ft bss	FEET BELOW SEDIME
I	ONE OR MORE SOIL S INTERMEDIATE INTERV
pg/g	PICOGRAMS PER GRA
OU-E	OPERABLE UNIT E
S	ONE OR MORE SOIL S SHALLOW INTERVAL (
TCDD	TETRACHLORODIBENZ
TEQ	TOXIC EQUIVALENT

AOI Boundary
Existing Structure
Former Structure

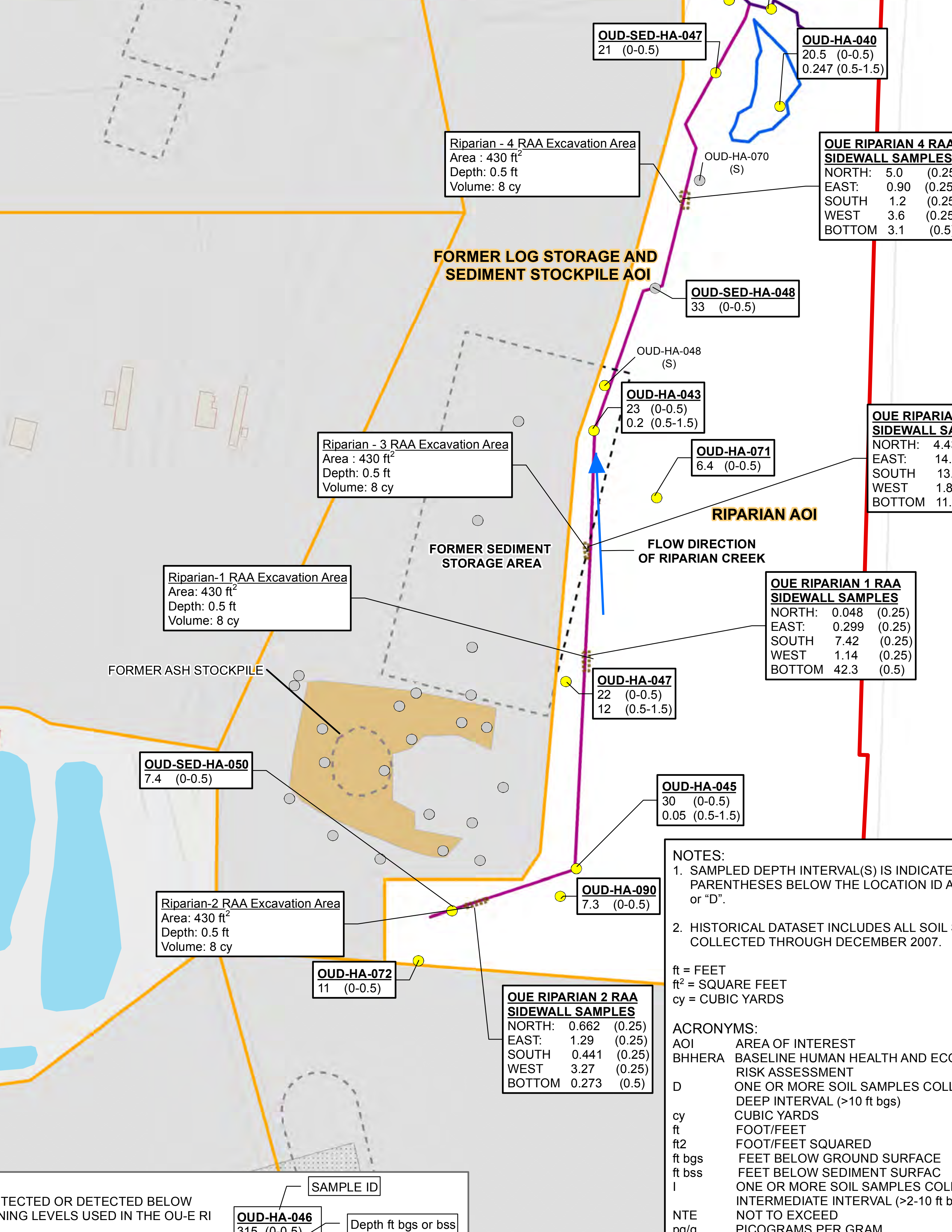
Plant Drain System Line
Sanitary Sewer Line
Unpaved Roadway
Paved Roadway

Pond1-02 — Sample ID
200 (0-0.5) — Depth (ft bss)
2,3,7,8-TCDD TEQ Concentration

N

For

Dioxi


OUD-SED-HA-047
21 (0-0.5)
OUD-HA-040
20.5 (0-0.5)
0.247 (0.5-1.5)
Riparian - 4 RAA Excavation Area
Area : 430 ft^2
Depth: 0.5 ft
Volume: 8 cy
OUD-HA-070
(S)
OUE RIPARIAN 4 RAA
SIDEWALL SAMPLES
NORTH: 5.0 (0.25
EAST: 0.90 (0.25
SOUTH 1.2 (0.25
WEST 3.6 (0.25
BOTTOM 3.1 (0.5
FORMER LOG STORAGE AND
SEDIMENT STOCKPILE AOI
OUD-SED-HA-048
33 (0-0.5)
OUD-HA-048
(S)
OUD-HA-043
23 (0-0.5)
0.2 (0.5-1.5)
OUE RIPARIA
SIDEWALL SA
NORTH: 4.4
EAST: 14.
SOUTH 13.
WEST 1.8
BOTTOM 11.
OUD-HA-071
6.4 (0-0.5)
Riparian - 3 RAA Excavation Area
Area : 430 ft^2
Depth: 0.5 ft
Volume: 8 cy
RIPARIAN AOI
FORMER SEDIMENT
STORAGE AREA
FLOW DIRECTION
OF RIPARIAN CREEK
Riparian-1 RAA Excavation Area
Area: 430 ft^2
Depth: 0.5 ft
Volume: 8 cy
OUE RIPARIAN 1 RAA
SIDEWALL SAMPLES
NORTH: 0.048 (0.25)
EAST: 0.299 (0.25)
SOUTH 7.42 (0.25)
WEST 1.14 (0.25)
BOTTOM 42.3 (0.5)
FORMER ASH STOCKPILE
OUD-HA-047
22 (0-0.5)
12 (0.5-1.5)
OUD-SED-HA-050
7.4 (0-0.5)
OUD-HA-045
30 (0-0.5)
0.05 (0.5-1.5)
NOTES:
1. SAMPLED DEPTH INTERVAL(S) IS INDICATE
PARENTHESES BELOW THE LOCATION ID A
or “D”.
2. HISTORICAL DATASET INCLUDES ALL SOIL
COLLECTED THROUGH DECEMBER 2007.
ft = FEET
ft^2 = SQUARE FEET
cy = CUBIC YARDS
ACRONYMS:
AOI AREA OF INTEREST
BHHERA BASELINE HUMAN HEALTH AND ECO
RISK ASSESSMENT
D ONE OR MORE SOIL SAMPLES COLL
DEEP INTERVAL (>10 ft bgs)
cy CUBIC YARDS
ft FOOT/FEET
ft2 FOOT/FEET SQUARED
ft bgs FEET BELOW GROUND SURFACE
ft bss FEET BELOW SEDIMENT SURFAC
I ONE OR MORE SOIL SAMPLES COLL
INTERMEDIATE INTERVAL (>2-10 ft b
NTE NOT TO EXCEED
pg/g PICOGRAMS PER GRAM
OUD-HA-090
7.3 (0-0.5)
Riparian-2 RAA Excavation Area
Area: 430 ft^2
Depth: 0.5 ft
Volume: 8 cy
OUD-HA-072
11 (0-0.5)
OUE RIPARIAN 2 RAA
SIDEWALL SAMPLES
NORTH: 0.662 (0.25)
EAST: 1.29 (0.25)
SOUTH 0.441 (0.25)
WEST 3.27 (0.25)
BOTTOM 0.273 (0.5)
TECTED OR DETECTED BELOW
NING LEVELS USED IN THE OU-E RI
SAMPLE ID
OUD-HA-046
Depth ft bgs or bss

Arsenic speciation

SITE BOUNDARY

OU-E BOUNDARY

NOTE:
TOTAL ORGANIC CARBON, GRAIN SIZE, pH, DISSOLVED OXYGEN, TEMPERATURE AND OXIDATION/REDUCTION POTENTIAL WAS COLLECTED FROM ALL SAMPLING LOCATIONS.

SITE BOUNDARY

OU-E BOUNDARY

NOTES:
TOTAL ORGANIC CARBON, GRAIN SIZE, pH, DISSOLVED OXYGEN, TEMPERATURE AND OXIDATION/REDUCTION POTENTIAL WAS COLLECTED FROM ALL SAMPLING LOCATIONS.

THE LOCATION OF POND 8-01 IS APPROXIMATE

N

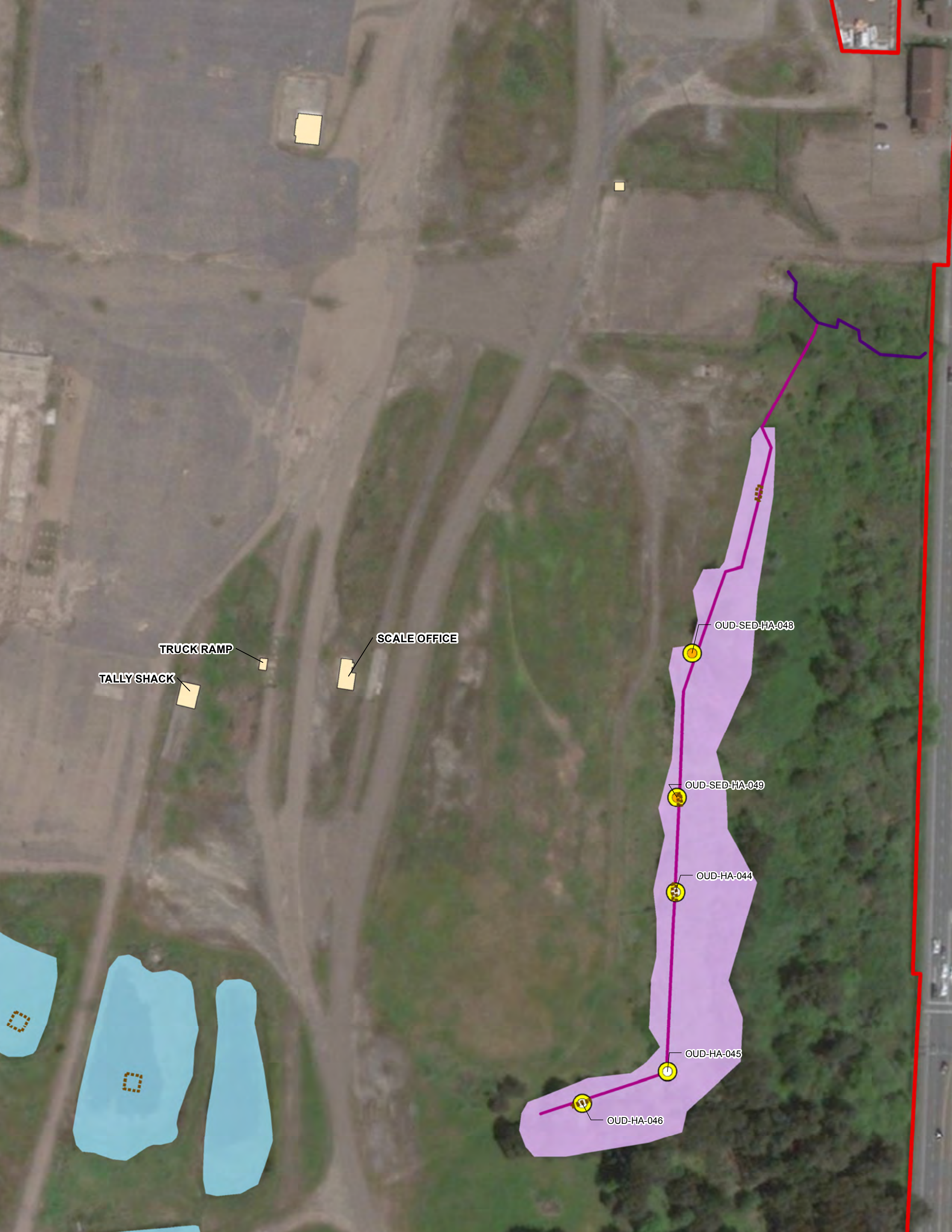
Arsenic speciation

OU-E BOUNDARY

NOTE:
TOTAL ORGANIC CARBON, GRAIN SIZE, pH, DISSOLVED OXYGEN, TEMPERATURE AND OXIDATION/REDUCTION POTENTIAL WAS COLLECTED FROM ALL SAMPLING LOCATIONS.

N

For



TRUCK RAMP
SCALE OFFICE
TALLY SHACK
OUD-SED-HA-048
OUD-SED-HA-049
OUD-HA-044
OUD-HA-045
OUD-HA-046

OU-E Terrestrial

Potential Exposure Media: Surface and Subsurface Soil → Future Surface Soil (0 to 0.5 or 0 to 2 ft bgs); Future Subsurface Soil* (to 6 or 10 ft bgs); Airborne Vapors (potentially complete if VOCs are identified). Surface and Subsurface Soil → Leaching from Soil to Groundwater → Groundwater; Airborne Vapors. Future Surface Soil and Future Subsurface Soil* → Airborne Soil Particulates.

Exposure Media	EXPOSURE PATHWAY(S)	Maintenance/Utility/ Trench Worker	Construction Worker	Commercial/Industrial Worker	Passive Adult/Child Recreator	Frequent Adult Recreator	Plants	Soil inverts	Birds	Mammals
		Potential Human Receptors					Potential Ecological Receptors			
Future Surface Soil (0 to 0.5 or 0 to 2 ft bgs)	Ingestion	✔	✔	✔	✔	✔			✔	✔
	Dermal/Direct Contact	✔	✔	✔	✔	✔	✔	✔	✔*	✔*
	Food/Prey Items								✔	✔
Airborne Soil Particulates	Inhalation	✔	✔	✔	✔	✔			✔*	✔*
Future Subsurface Soil* (to 6 or 10 ft bgs)	Ingestion	✔	✔	✔						✔
	Dermal/Direct Contact	✔	✔	✔			✔			✔*
	Food/Prey Items								✔	✔
Airborne Vapors	Inhalation	✔*	✔*	✔*	✔*	✔*			✔*	✔*
Groundwater	Ingestion									
	Dermal/Direct Contact	✔	✔				✔			

Notes:

- —·→ Potentially complete pathway if VOCs are identified as
- ✔ Potentially complete exposure pathwa
- ✔* Potentially complete but likely insignficant pathway
- (Highlighted) Additional receptor from those approved in the June 2008 *Site-Wide Risk Assessment Work Plan* (submitted by ARCADIS on behalf of Georgia-Pacific), included in order to assess the potential use of the site as a commerical property.

COPC = chemical of potential concern
ft bgs = feet below ground surface
OU = operable unit
VOC = volatile organic compounds

* Note that where depth of groundwater is shallow, exposure depths will be llmited to 2 feet below the groundwater table.

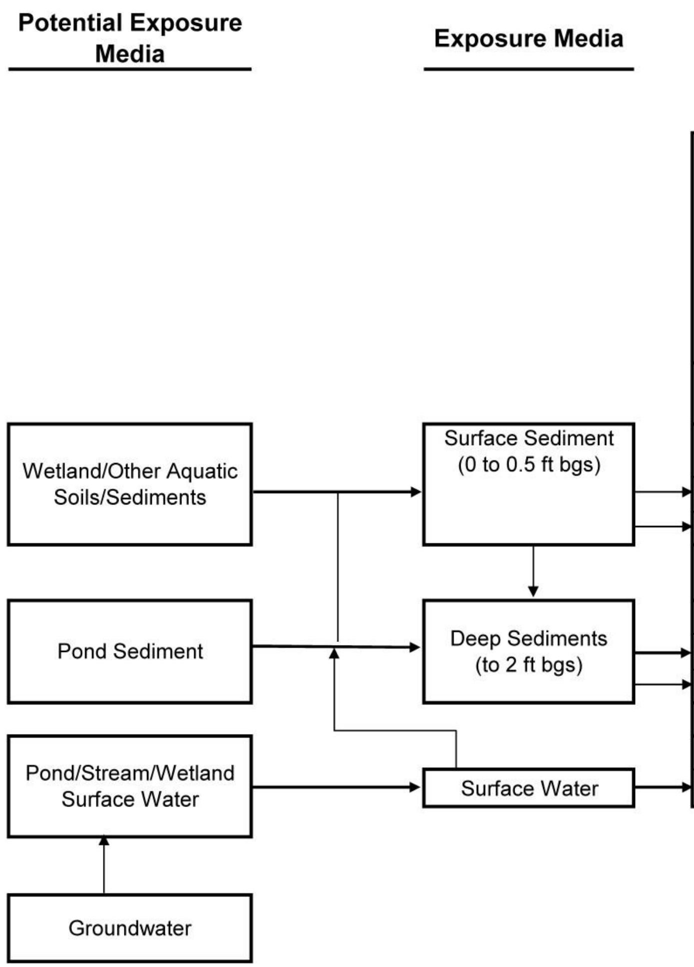
Kennedy/Jenks Consultants

Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Lowland Terrestrial Conceptual Site Model

1665018*18

Figure 2-31



OU-E Wetland/Aquatic

Exposure Media	EXPOSURE PATHWAY(S)	Potential Human Receptor: Passive Adult/Child Recreator [a]	Potential Ecological Receptors: Aquatic Plants	Benthic inverts	Amphibians	Birds	Mammals
Surface Sediment (0 to 0.5 ft bgs)	Ingestion	✔			✔	✔	✔
	Dermal/Direct Contact	✔	✔	✔	✔	✔*	✔*
	Food/Prey Items				✔	✔	✔
Deep Sediments (to 2 ft bgs)	Ingestion						✔
	Dermal/Direct Contact		✔				✔*
	Food/Prey Items					✔	✔
Surface Water	Ingestion				✔	✔	✔
	Dermal/Direct Contact	✔	✔	✔	✔	✔*	✔*

Notes:
✔ Potentially complete exposure pathway
✔* Potentially complete but likely insignficant pathway

COPC = chemical of potential concern
ft bgs = feet below ground surface
OU = operable unit
[a] Recreators are unlikely to be frequently exposed to surface water and sediment but this pathway will be quantitatively evaluated to be protective.

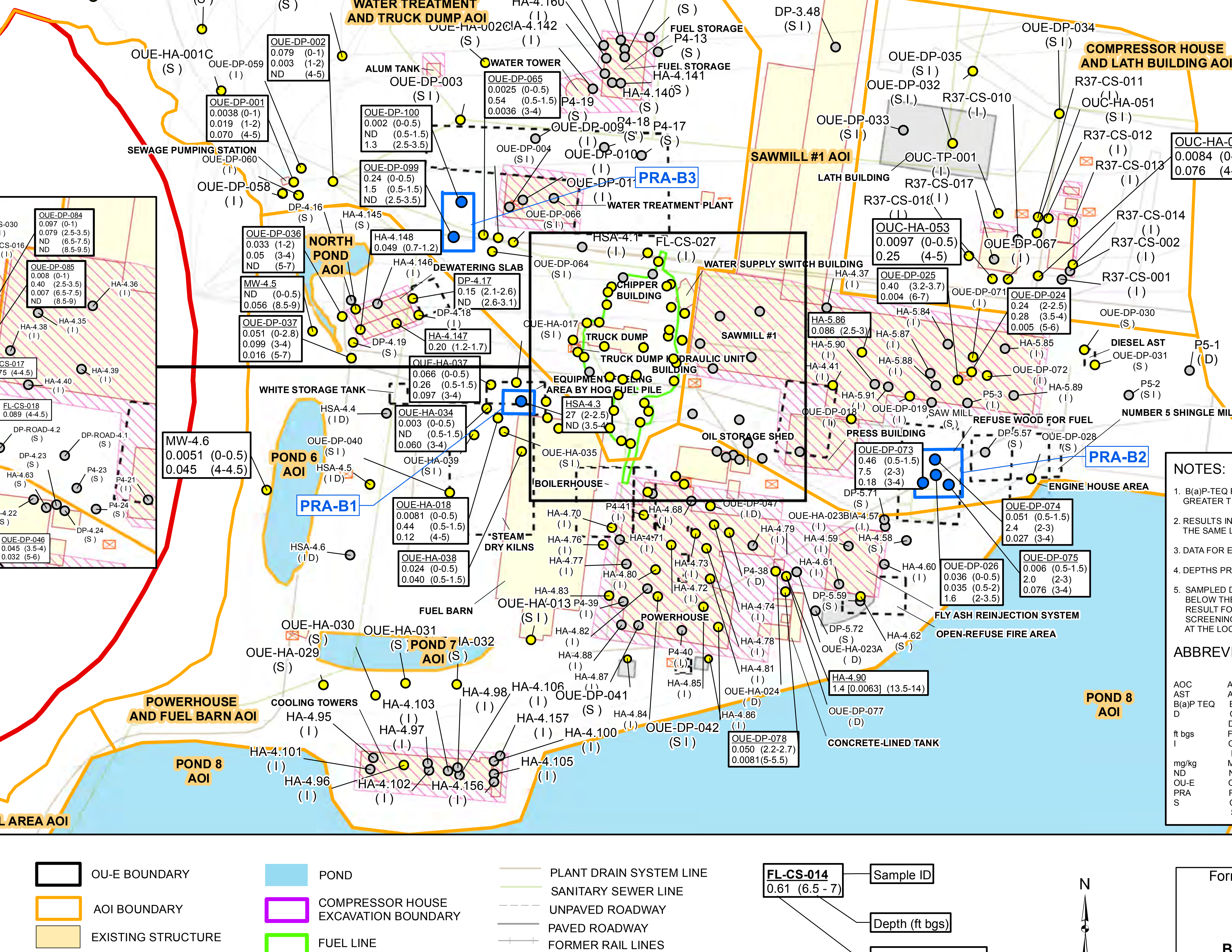
Kennedy/Jenks Consultants

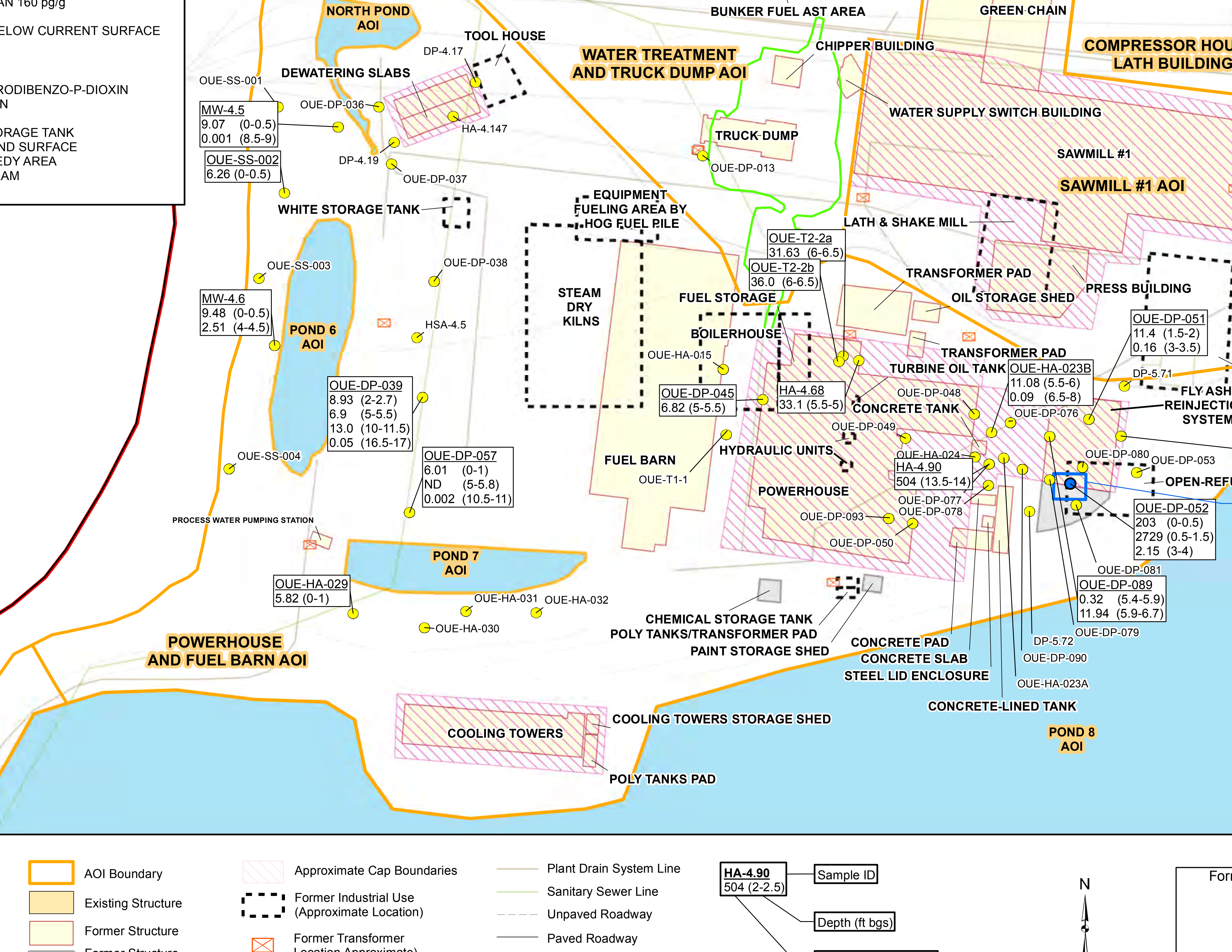
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

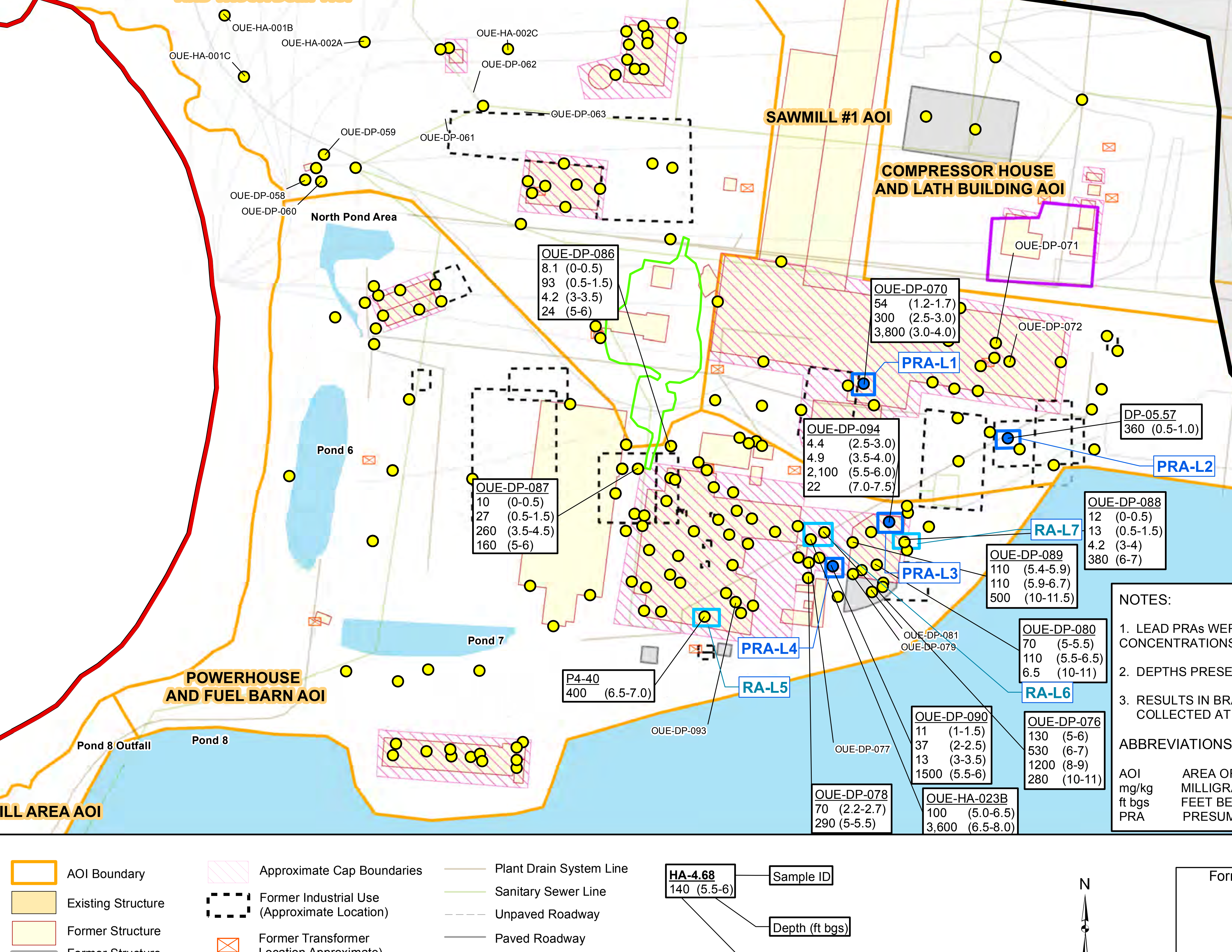
Aquatic Area Conceptual Site Model

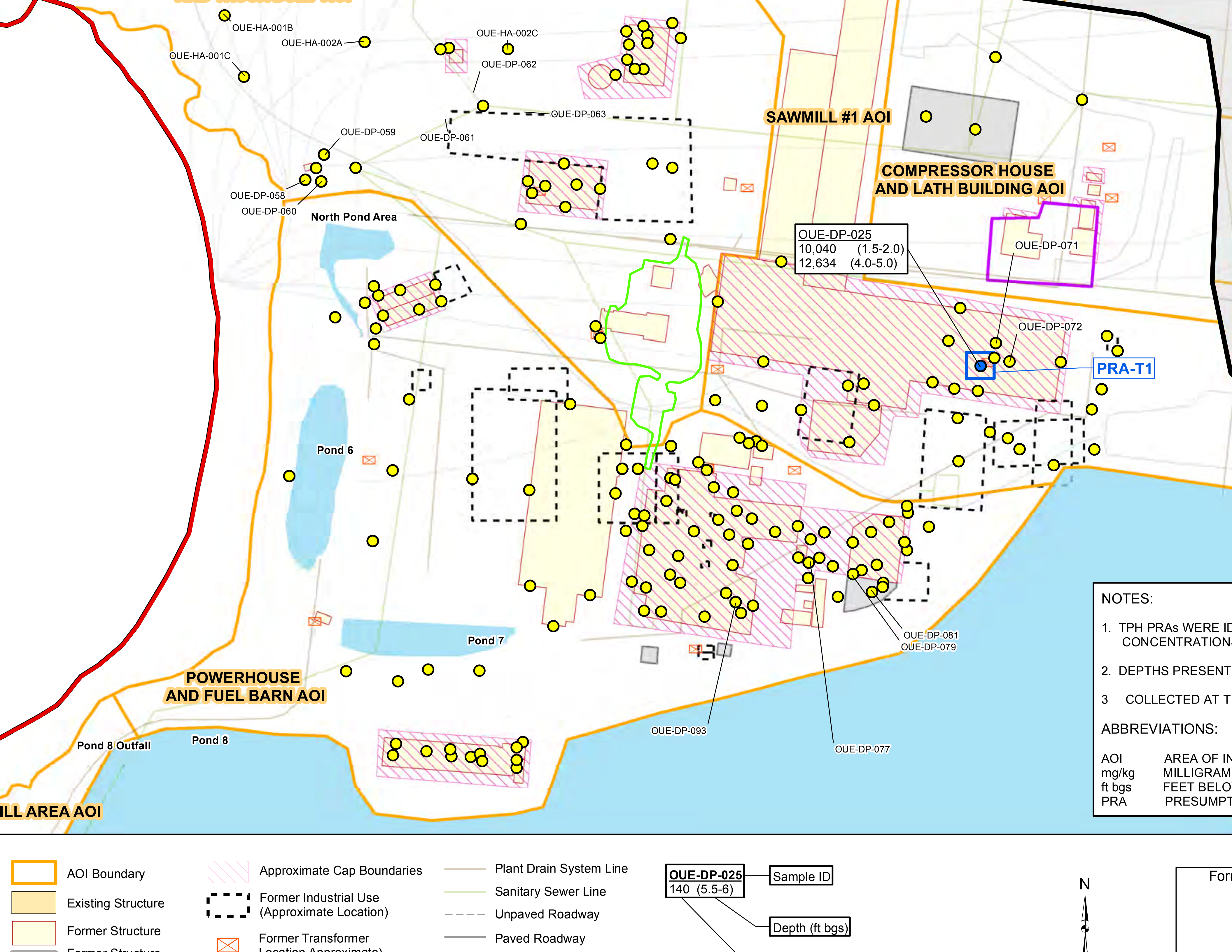
1665018*18

Figure 2-32


WATER TREATMENT AND TRUCK DUMP AOI
COMPRESSOR HOUSE AND LATH BUILDING AOI
SAWMILL #1 AOI
NORTH POND AOI
POND 6 AOI
POND 7 AOI
POND 8 AOI
POWERHOUSE AND FUEL BARN AOI
PRA-B1
PRA-B2
PRA-B3
OUE-DP-002 0.079 (0-1) 0.003 (1-2) ND (4-5)
OUE-DP-001 0.0038 (0-1) 0.019 (1-2) 0.070 (4-5)
OUE-DP-065 0.0025 (0-0.5) 0.54 (0.5-1.5) 0.0036 (3-4)
OUE-DP-100 0.002 (0-0.5) ND (0.5-1.5) 1.3 (2.5-3.5)
OUE-DP-099 0.24 (0-0.5) 1.5 (0.5-1.5) ND (2.5-3.5)
OUE-DP-036 0.033 (1-2) 0.05 (3-4) ND (5-7)
MW-4.5 ND (0-0.5) 0.056 (8.5-9)
OUE-DP-037 0.051 (0-2.8) 0.099 (3-4) 0.016 (5-7)
HA-4.148 0.049 (0.7-1.2)
DP-4.17 0.15 (2.1-2.6) ND (2.6-3.1)
HA-4.147 0.20 (1.2-1.7)
OUE-HA-037 0.066 (0-0.5) 0.26 (0.5-1.5) 0.097 (3-4)
OUE-HA-034 0.003 (0-0.5) ND (0.5-1.5) 0.060 (3-4)
HSA-4.3 27 (2-2.5) ND (3.5-4)
OUE-HA-018 0.0081 (0-0.5) 0.44 (0.5-1.5) 0.12 (4-5)
OUE-HA-038 0.024 (0-0.5) 0.040 (0.5-1.5)
MW-4.6 0.0051 (0-0.5) 0.045 (4-4.5)
OUE-DP-084 0.097 (0-1) 0.079 (2.5-3.5) ND (6.5-7.5) ND (8.5-9.5)
OUE-DP-085 0.008 (0-1) 0.40 (2.5-3.5) 0.007 (6.5-7.5) ND (8.5-9)
FL-CS-018 0.089 (4-4.5)
OUE-DP-046 0.045 (3.5-4) 0.032 (5-6)
OUC-HA-053 0.0097 (0-0.5) 0.25 (4-5)
OUE-DP-025 0.40 (3.2-3.7) 0.004 (6-7)
OUE-DP-024 0.24 (2-2.5) 0.28 (3.5-4) 0.005 (5-6)
HA-5.86 0.086 (2.5-3)
OUE-DP-073 0.46 (0.5-1.5) 7.5 (2-3) 0.18 (3-4)
OUE-DP-074 0.051 (0.5-1.5) 2.4 (2-3) 0.027 (3-4)
OUE-DP-026 0.036 (0-0.5) 0.035 (0.5-2) 1.6 (2-3.5)
OUE-DP-075 0.006 (0.5-1.5) 2.0 (2-3) 0.076 (3-4)
HA-4.90 1.4 [0.0063] (13.5-14)
OUE-DP-078 0.050 (2.2-2.7) 0.0081 (5-5.5)
ALUM TANK
WATER TOWER
FUEL STORAGE
SEWAGE PUMPING STATION
DEWATERING SLAB
WATER TREATMENT PLANT
LATH BUILDING
WATER SUPPLY SWITCH BUILDING
CHIPPER BUILDING
TRUCK DUMP
TRUCK DUMP HYDRAULIC UNIT BUILDING
SAWMILL #1
EQUIPMENT FUELING AREA BY HOG FUEL PILE
WHITE STORAGE TANK
OIL STORAGE SHED
PRESS BUILDING
SAW MILL
REFUSE WOOD FOR FUEL
DIESEL AST
NUMBER 5 SHINGLE MILL
ENGINE HOUSE AREA
BOILERHOUSE
STEAM DRY KILNS
FUEL BARN
POWERHOUSE
COOLING TOWERS
FLY ASH REINJECTION SYSTEM
OPEN-REFUSE FIRE AREA
CONCRETE-LINED TANK
NOTES:
OU-E BOUNDARY
AOI BOUNDARY
EXISTING STRUCTURE
POND
COMPRESSOR HOUSE EXCAVATION BOUNDARY
FUEL LINE
PLANT DRAIN SYSTEM LINE
SANITARY SEWER LINE
UNPAVED ROADWAY
PAVED ROADWAY
FORMER RAIL LINES
FL-CS-014 0.61 (6.5 - 7)
Sample ID
Depth (ft bgs)
N


AN 160 pg/g
ELOW CURRENT SURFACE
RODIBENZO-P-DIOXIN
N
RAGE TANK
ND SURFACE
EDY AREA
AM
NORTH POND AOI
TOOL HOUSE
DP-4.17
DEWATERING SLABS
OUE-SS-001
MW-4.5
9.07 (0-0.5)
0.001 (8.5-9)
OUE-DP-036
HA-4.147
OUE-SS-002
6.26 (0-0.5)
DP-4.19
OUE-DP-037
WHITE STORAGE TANK
WATER TREATMENT AND TRUCK DUMP AOI
BUNKER FUEL AST AREA
CHIPPER BUILDING
GREEN CHAIN
COMPRESSOR HOU
LATH BUILDING
WATER SUPPLY SWITCH BUILDING
TRUCK DUMP
OUE-DP-013
SAWMILL #1
SAWMILL #1 AOI
EQUIPMENT FUELING AREA BY HOG FUEL PILE
LATH & SHAKE MILL
OUE-T2-2a
31.63 (6-6.5)
OUE-T2-2b
36.0 (6-6.5)
TRANSFORMER PAD
PRESS BUILDING
OIL STORAGE SHED
STEAM DRY KILNS
FUEL STORAGE
BOILERHOUSE
OUE-HA-015
OUE-DP-045
6.82 (5-5.5)
HA-4.68
33.1 (5.5-5)
TRANSFORMER PAD
TURBINE OIL TANK
OUE-HA-023B
11.08 (5.5-6)
0.09 (6.5-8)
OUE-DP-051
11.4 (1.5-2)
0.16 (3-3.5)
DP-5.71
FLY ASH
REINJECTI
SYSTEM
OUE-DP-048
CONCRETE TANK
OUE-DP-076
OUE-DP-049
HYDRAULIC UNITS
OUE-HA-024
HA-4.90
504 (13.5-14)
OUE-DP-080
OUE-DP-053
OPEN-REF
FUEL BARN
OUE-T1-1
POWERHOUSE
OUE-DP-077
OUE-DP-078
OUE-DP-093
OUE-DP-050
OUE-DP-052
203 (0-0.5)
2729 (0.5-1.5)
2.15 (3-4)
OUE-DP-081
OUE-DP-089
0.32 (5.4-5.9)
11.94 (5.9-6.7)
OUE-DP-079
DP-5.72
OUE-DP-090
OUE-HA-023A
OUE-SS-003
MW-4.6
9.48 (0-0.5)
2.51 (4-4.5)
POND 6 AOI
OUE-DP-038
HSA-4.5
OUE-DP-039
8.93 (2-2.7)
6.9 (5-5.5)
13.0 (10-11.5)
0.05 (16.5-17)
OUE-DP-057
6.01 (0-1)
ND (5-5.8)
0.002 (10.5-11)
OUE-SS-004
PROCESS WATER PUMPING STATION
POND 7 AOI
OUE-HA-029
5.82 (0-1)
OUE-HA-031
OUE-HA-032
OUE-HA-030
CHEMICAL STORAGE TANK
POLY TANKS/TRANSFORMER PAD
PAINT STORAGE SHED
CONCRETE PAD
CONCRETE SLAB
STEEL LID ENCLOSURE
CONCRETE-LINED TANK
POND 8 AOI
POWERHOUSE AND FUEL BARN AOI
COOLING TOWERS
COOLING TOWERS STORAGE SHED
POLY TANKS PAD
AOI Boundary
Existing Structure
Former Structure
Approximate Cap Boundaries
Former Industrial Use (Approximate Location)
Former Transformer Location (Approximate)
Plant Drain System Line
Sanitary Sewer Line
Unpaved Roadway
Paved Roadway
HA-4.90
504 (2-2.5)
Sample ID
Depth (ft bgs)
N
For


SAWMILL #1 AOI
COMPRESSOR HOUSE AND LATH BUILDING AOI
POWERHOUSE AND FUEL BARN AOI
ILL AREA AOI
North Pond Area
Pond 6
Pond 7
Pond 8
Pond 8 Outfall
OUE-HA-001B
OUE-HA-002A
OUE-HA-001C
OUE-HA-002C
OUE-DP-062
OUE-DP-063
OUE-DP-061
OUE-DP-059
OUE-DP-058
OUE-DP-060
OUE-DP-071
OUE-DP-072
OUE-DP-081
OUE-DP-079
OUE-DP-093
OUE-DP-077
PRA-L1
PRA-L2
PRA-L3
PRA-L4
RA-L5
RA-L6
RA-L7
OUE-DP-086
8.1 (0-0.5)
93 (0.5-1.5)
4.2 (3-3.5)
24 (5-6)
OUE-DP-087
10 (0-0.5)
27 (0.5-1.5)
260 (3.5-4.5)
160 (5-6)
OUE-DP-070
54 (1.2-1.7)
300 (2.5-3.0)
3,800 (3.0-4.0)
OUE-DP-094
4.4 (2.5-3.0)
4.9 (3.5-4.0)
2,100 (5.5-6.0)
22 (7.0-7.5)
DP-05.57
360 (0.5-1.0)
OUE-DP-088
12 (0-0.5)
13 (0.5-1.5)
4.2 (3-4)
380 (6-7)
OUE-DP-089
110 (5.4-5.9)
110 (5.9-6.7)
500 (10-11.5)
OUE-DP-080
70 (5-5.5)
110 (5.5-6.5)
6.5 (10-11)
OUE-DP-090
11 (1-1.5)
37 (2-2.5)
13 (3-3.5)
1500 (5.5-6)
OUE-DP-076
130 (5-6)
530 (6-7)
1200 (8-9)
280 (10-11)
OUE-DP-078
70 (2.2-2.7)
290 (5-5.5)
OUE-HA-023B
100 (5.0-6.5)
3,600 (6.5-8.0)
P4-40
400 (6.5-7.0)
NOTES:
1. LEAD PRAs WER
CONCENTRATIONS
2. DEPTHS PRESE
3. RESULTS IN BRA
COLLECTED AT
ABBREVIATIONS
AOI AREA OF
mg/kg MILLIGRA
ft bgs FEET BE
PRA PRESUM
AOI Boundary
Existing Structure
Former Structure
Approximate Cap Boundaries
Former Industrial Use (Approximate Location)
Former Transformer
Plant Drain System Line
Sanitary Sewer Line
Unpaved Roadway
Paved Roadway
HA-4.68
140 (5.5-6)
Sample ID
Depth (ft bgs)
N
For



OUE-HA-001B
OUE-HA-002A
OUE-HA-001C
OUE-HA-002C
OUE-DP-062
OUE-DP-063
OUE-DP-061
OUE-DP-059
OUE-DP-058
OUE-DP-060
North Pond Area
SAWMILL #1 AOI
COMPRESSOR HOUSE AND LATH BUILDING AOI
OUE-DP-071
OUE-DP-025
10,040 (1.5-2.0)
12,634 (4.0-5.0)
OUE-DP-072
PRA-T1
Pond 6
Pond 7
OUE-DP-081
OUE-DP-079
OUE-DP-093
OUE-DP-077
POWERHOUSE AND FUEL BARN AOI
Pond 8 Outfall
Pond 8
ILL AREA AOI
NOTES:
1. TPH PRAs WERE ID
CONCENTRATION
2. DEPTHS PRESENT
3 COLLECTED AT T
ABBREVIATIONS:
AOI AREA OF IN
mg/kg MILLIGRAM
ft bgs FEET BELO
PRA PRESUMPT
AOI Boundary
Existing Structure
Former Structure
Approximate Cap Boundaries
Former Industrial Use (Approximate Location)
Former Transformer Location Approximate)
Plant Drain System Line
Sanitary Sewer Line
Unpaved Roadway
Paved Roadway
OUE-DP-025
140 (5.5-6)
Sample ID
Depth (ft bgs)
N
For

Appendix A

Cost Summary Tables for Sediment Remediation Alternatives and Groundwater Remediation Alternatives

Former Georgia Pacific Wood Products Facility
Fort Bragg, California

Line Item	Unit Price	Units	Source
sts			
	Varies by AOC	per Square Foot	Assumed $0.16 per sf of AOI area, consistent with the OU-C/D FS.
	$3,000	per mob	Based on <1 day 2017 survey at site.
	$50,000	Lump Sum	Typical cost based on previous work completed
	$20,000	Lump Sum	Typical cost based on previous work completed
	$40,000	Lump Sum	Typical cost based on previous work completed
	$2,165,000	Lump Sum	Cost estimate prepared for DSOD Application, includes $1,020,000 Rock Slope Protection, $175,000 Spillway $420,000 Pond Separation, $550,000 Soil Buttress.
nd Long-Term O&M	$210,000	Lump Sum	Based on repair/replacement of portions of beach berm armoring in year 30 of estimate, adjusted to NPV in A
	Varies by AOC	percent	Typically 10% of project cost
d oversight	Varies by AOC	percent	Typically 10% of Construction Costs
	$150,000	Lump Sum	Typical permitting cost for this project, based on previous work at the site, includes biolgoical surveys, cultrual and reports, stormwater, air, city, and resource agency permits
ation	$40,000	Lump Sum	Based on 2017 excavation effort
	$60	per Cubic Yard	Based on 2017 excavation effort. Earthwork effort assumed to be similar for excavation as installation of cove
0% cover replacement annually)	Varies by AOC	Years (NPV)	An annual replacement rate of 10% is assumed for the wet vegetative cover alternatives. This replacement ra sediment cap replacement in areas of active water flow and likely sediment cover scour and transport.
	$50,000 - $250,000	per Acre	Based on creation of wetland establishment area as part of 2017 excavation effort. Restoration costs greater t to be an increased unit price due to higher scale of level of effort, including significant earthwork and creek da meet larger area requirments. A mitigation ratio of 4:1 was assumed. If existing pond remains a pond or wetla implemented, the existing structure was counted as part of the mitigation (i.e., create new wetland area equal pond area to achieve 4:1 mitigation). In this scenario, the pond area would require reseeding but not the effort area, and therefore was included in the hydroseed line item but not included in the restoration line item. If the remain after the alternative is implemented, create new wetland area equal to four times the pond area to achi
d Office Support	$2,900	per Day	Based on 2017 excavation effort. Assumes full-time engineering oversight in field with support from the office
osts (Per Diem, etc)	$1,000	per Day	Based on 2017 excavation effort. Average contractor team size of four, including one supervisor and one oper
el	$600	per Day	Based on 2017 excavation effort
	$2,300	per Day	Based on 2017 excavation effort. Includes Contractor vehicles, water truck, on-site trucking, skid steer, mini-e excavator (335F).
	$20	per Cubic Yard	Based on 2017 excavation effort. Assumes Contractor labor was equally divided between excavation, backfill, sediment management.
t Management	$20	per Cubic Yard	Based on 2017 excavation effort. Assumes Contractor labor was equally divided between excavation, backfill, sediment management.
posal (Class 2 Non-Hazardous)	$80	Tons	Based on 2017 excavation effort
Monitoring	$1,800	per Day	Based on 2017 excavation effort. Assumes monitors on-site as needed (not full-time).
	$9,900	per Acre	Based on 2017 excavation effort
	$50	per Cubic Yard	Unit cost based on the in-situ soil mixing cost presented in the Remediation Technologies Screening Matrix ar Version 4.0 (https://frtr.gov/matrix2/top_page.html).
, deed restriction	Varies by AOC	Lump Sum	Assumed $0.16 per sf of AOI area, consistent with the OU-C/D FS.
	$39,000	Lump Sum	Assumed cost is 1.5x the Delineation/Survey cost, consistent with the OU-C/D FS.
g and reporting cost	$1,900	per well	Based on 2017 costs
st	$400	per well	Based on 2016 laboratory invoices
reparation	Varies	Lump Sum	Typically 10% of implementation costs
	$53,600	Lump Sum	Based on recent cost estimate from contractor. Assumes 25% well coverage (16 injection wells).

Former Georgia Pacific Wood Products Facility
Fort Bragg, California

	Ponds 1 through 4 (Southern Ponds) AOC				Pond 7 AOC				North Pond and Pond 6 AOC				Pond		
Nature and Extent	• Arsenic, Dioxin TEQ • 122,000 sf • 7,000 cy to depth of 2.5 feet				• Arsenic, Dioxin TEQ • 5,000 sf • 900 cy average depth of 5 feet				• Arsenic, Dioxin TEQ • 3,000 sf (North Pond); 7,000 sf (Pond 6) • 3,200 cy to depth of 5 feet				• Dioxin TEQ • 280,000 sf • 106,000 cy average depth of 10		
ternative Cost Estimates and Assumptions	Quantity [1.]	Units	Unit Rate	NPV Cost	Quantity [1.]	Units	Unit Rate	NPV Cost	Quantity [1.]	Units	Unit Rate	NPV Cost	Quantity [1.]	Units	
	No Action				No Action				No Action				No Action		
	No remediation activities required				No remediation activities required				No remediation activities required				No remediation activities required		
				$ -				$ -				$ -			
ls	Institutional Controls				Institutional Controls				Institutional Controls				Institutional Controls		
	Deed restriction, survey, SMP				Deed restriction, survey, SMP				Deed restriction, survey, SMP				Containment, deed restriction, su		
ey	1	Lump Sum	$ 20,000	$ 20,000	1	Lump Sum	$ 1,000	$ 1,000	1	Lump Sum	$ 2,000	$ 2,000	1	Lump Sum	$
	1	Lump Sum	$ 50,000	$ 50,000	1	Lump Sum	$ 50,000	$ 50,000	1	Lump Sum	$ 50,000	$ 50,000	1	Lump Sum	$
	1	Lump Sum	$ 20,000	$ 20,000	1	Lump Sum	$ 20,000	$ 20,000	1	Lump Sum	$ 20,000	$ 20,000	1	Lump Sum	$
an	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$
	Not Applicable				Not Applicable				Not Applicable				1	Lump Sum	$
rs Present Dollars	Not Applicable				Not Applicable				Not Applicable				1	Lump Sum	$
ction and Long-Term O&M V + 5 yr survey)	Not Applicable				Not Applicable				Not Applicable				30	Years (NPV)	$
at year 30	Not Applicable				1	NPV of repair	$ 210,000	$ 28,000	1	NPV of repair	$ 210,000	$ 28,000	1	NPV of repair	$
on and Long-Term O&M ($1,000/acre/year NPV)	Not Applicable				30	Years (NPV)	$ 2,000	$ 7,000	30	Years (NPV)	$ 1,000	$ 7,000	30	Years (NPV)	$
	Not Applicable				Not Applicable				Not Applicable				1.3	Acres	$
	Not Applicable				Not Applicable				Not Applicable				0.8	Acres	$
	1	10% of subtotal	$ 13,000	$ 13,000	1	10% of subtotal	$ 14,600	$ 15,000	1	10% of subtotal	$ 14,700	$ 15,000	1	10% of subtotal	$
				$ 143,000				$ 161,000				$ 162,000			
	Vegetative Cover (Wet)				Vegetative Cover (Wet)				Vegetative Cover (Wet)				Vegetative Cover (Wet)		
	122,000 sf vegetative cover 2 feet thick, restoration of 8.7 acres as wet meadow (includes ponds)				5,000 sf vegetative cover 2 feet thick, restoration of 0.6 acres as wet meadow (includes pond)				10,000 sf vegetative cover 2 feet thick, restoration of 0.9 acres as wet meadow (includes ponds)				280,000 sf vegetative cover 2 fee creek restoration (includes pond)		
and oversight (10% of Construction)	1	Lump Sum	$ 181,000	$ 181,000	1	Lump Sum	$ 13,000	$ 13,000	1	Lump Sum	$ 20,000	$ 20,000	1	Lump Sum	$
	1	Lump Sum	$ 150,000	$ 150,000	1	Lump Sum	$ 150,000	$ 150,000	1	Lump Sum	$ 150,000	$ 150,000	1	Lump Sum	$
zation	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$
	9,040	Cubic Yards	$ 60	$ 542,400	380	Cubic Yards	$ 60	$ 22,800	750	Cubic Yards	$ 60	$ 45,000	21,000	Cubic Yards	$
(10% cover replacement annually[3])	30	Years (NPV)	$ 54,240	$ 673,100	30	Years (NPV)	$ 2,280	$ 28,300	30	Years (NPV)	$ 4,500	$ 55,900	30	Years (NPV)	$
	11.6	Acres	$ 9,900	$ 114,840	0.8	Acres	$ 9,900	$ 7,920	1.2	Acres	$ 9,900	$ 11,880	26	Acres	$
	8.7	Acres	$ 50,000	$ 435,000	0.6	Acres	$ 50,000	$ 30,000	0.9	Acres	$ 50,000	$ 45,000	20	Acres	$
	1	Lump Sum	$ 50,000	$ 50,000	1	Lump Sum	$ 50,000	$ 50,000	1	Lump Sum	$ 50,000	$ 50,000	1	Lump Sum	$
	1	Lump Sum	$ 20,000	$ 20,000	1	Lump Sum	$ 20,000	$ 20,000	1	Lump Sum	$ 20,000	$ 20,000	1	Lump Sum	$
an	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$
rs Present Dollars	Not Applicable				Not Applicable				Not Applicable				1	Lump Sum	$
ction and Long-Term O&M V + 5 yr survey)	Not Applicable				Not Applicable				Not Applicable				30	Years (NPV)	$
at year 30	Not Applicable				1	NPV of repair	$ 210,000	$ 28,000	1	NPV of repair	$ 210,000	$ 28,000	1	NPV of repair	$
on and Long-Term O&M ($1,000/acre/year NPV)	Not Applicable				30	Years (NPV)	$ 1,000	$ 7,000	30	Years (NPV)	$ 1,000	$ 7,000	30	Years (NPV)	$
	1	10% of subtotal	$ 224,634	$ 225,000	1	10% of subtotal	$ 43,702	$ 44,000	1	10% of subtotal	$ 51,278	$ 52,000	1	10% of subtotal	$
				$ 2,471,340				$ 481,020				$ 564,780			
	Vegetative Cover (Dry)				Vegetative Cover (Dry)				Vegetative Cover (Dry)				Vegetative Cover (Dry)		
	122,000 sf vegetative cover 2 feet thick plus fill to rim of pond, restoration of 11.6 acres as wet meadow (excludes ponds)				5,000 sf vegetative cover 2 feet thick plus fill to rim of pond (11 feet), restoration of 0.8 acres as wet meadow (excludes pond)				10,000 sf vegetative cover 2 feet thick plus depth of water, restoration of 1.2 acres as wet meadow (excludes ponds)				280,000 sf vegetative cover 3 fee creek restoration, divert water flo		
and oversight (10% of Construction)	1	Lump Sum	$ 358,000	$ 358,000	1	Lump Sum	$ 24,000	$ 24,000	1	Lump Sum	$ 27,000	$ 27,000	1	Lump Sum	$
	1	Lump Sum	$ 150,000	$ 150,000	1	Lump Sum	$ 150,000	$ 150,000	1	Lump Sum	$ 150,000	$ 150,000	1	Lump Sum	$
zation	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$
	46,790	Cubic Yards	$ 60	$ 2,807,400	2,410	Cubic Yards	$ 60	$ 144,600	2,520	Cubic Yards	$ 60	$ 151,200	31,500	Cubic Yards	$
($1,000/acre/year NPV)	30	Years (NPV)	$ 2,900	$ 35,986	30	Years (NPV)	$ 200	$ 2,500	30	Years (NPV)	$ 300	$ 3,800	30	Years (NPV)	$
	11.6	Acres	$ 9,900	$ 114,840	0.8	Acres	$ 9,900	$ 7,920	1.2	Acres	$ 9,900	$ 11,880	26	Acres	$
	11.6	Acres	$ 50,000	$ 580,000	0.8	Acres	$ 50,000	$ 40,000	1.2	Acres	$ 50,000	$ 60,000	26	Acres	$
	1	Lump Sum	$ 50,000	$ 50,000	1	Lump Sum	$ 50,000	$ 50,000	1	Lump Sum	$ 50,000	$ 50,000	1	Lump Sum	$
	1	Lump Sum	$ 20,000	$ 20,000	1	Lump Sum	$ 20,000	$ 20,000	1	Lump Sum	$ 20,000	$ 20,000	1	Lump Sum	$
an	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$
rs Present Dollars	Not Applicable				Not Applicable				Not Applicable				1	Lump Sum	$
ction and Long-Term O&M ($1,000/acre/year NPV)	Not Applicable				Not Applicable				Not Applicable				30	Years (NPV)	$
at year 30	Not Applicable				1	NPV of repair	$ 210,000	$ 28,000	1	NPV of repair	$ 210,000	$ 28,000	1	NPV of repair	$
on and Long-Term O&M	Not Applicable				30	Years (NPV)	$ 1,000	$ 7,000	30	Years (NPV)	$ 1,000	$ 7,000	30	Years (NPV)	$

Former Georgia Pacific Wood Products Facility
Fort Bragg, California

	Ponds 1 through 4 (Southern Ponds) AOC				Pond 7 AOC				North Pond and Pond 6 AOC				Pond		
Nature and Extent	**• Arsenic, Dioxin TEQ • 122,000 sf • 7,000 cy to depth of 2.5 feet**				**• Arsenic, Dioxin TEQ • 5,000 sf • 900 cy average depth of 5 feet**				**• Arsenic, Dioxin TEQ • 3,000 sf (North Pond); 7,000 sf (Pond 6) • 3,200 cy to depth of 5 feet**				**• Dioxin TEQ • 280,000 sf • 106,000 cy average depth of 10**		
ternative Cost Estimates and Assumptions	**Quantity [1.]**	**Units**	**Unit Rate**	**NPV Cost**	**Quantity [1.]**	**Units**	**Unit Rate**	**NPV Cost**	**Quantity [1.]**	**Units**	**Unit Rate**	**NPV Cost**	**Quantity [1.]**	**Units**	
posal	**Excavation and Disposal**				**Excavation and Disposal**				**Excavation and Disposal**				**Excavation and Disposal**		
nt 2017 excavation effort	Excavation and offsite disposal of 7,000 cy, restoration mitigation of 8.7 acres as wet meadow (includes ponds)				Excavation and offsite disposal of 900 cy, restoration mitigation of 0.6 acres as wet meadow (includes pond)				Excavation and offsite disposal of 3,200 cy, restoration mitigation of 0.9 acres as wet meadow (includes ponds)				Excavation and offsite disposal o of 20 acres as stream restoration		
struction)	1	Lump Sum	$ 180,000	$ 180,000	1	Lump Sum	$ 30,000	$ 30,000	1	Lump Sum	$ 70,000	$ 70,000	1	Lump Sum	$
	1	Lump Sum	$ 150,000	$ 150,000	1	Lump Sum	$ 150,000	$ 150,000	1	Lump Sum	$ 150,000	$ 150,000	1	Lump Sum	$
and Office Support	23	Days	$ 2,900	$ 66,700	3	Days	$ 2,900	$ 8,700	11	Days	$ 2,900	$ 31,900	350	Days	$
zation	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$ 40,000	$ 40,000	1	Lump Sum	$
Costs (Per Diem, etc)	23	Days	$ 1,000	$ 23,000	3	Days	$ 1,000	$ 3,000	11	Days	$ 1,000	$ 11,000	348	Days	$
uel	23	Days	$ 600	$ 13,800	3	Days	$ 600	$ 1,800	11	Days	$ 600	$ 6,600	348	Days	$
	23	Days	$ 2,300	$ 52,900	3	Days	$ 2,300	$ 6,900	11	Days	$ 2,300	$ 25,300	348	Days	$
	7,000	Cubic Yards	$ 20	$ 140,000	900	Cubic Yards	$ 20	$ 18,000	3,200	Cubic Yards	$ 20	$ 64,000	106,000	Cubic Yards	$
ent Management	7,000	Cubic Yards	$ 20	$ 140,000	900	Cubic Yards	$ 20	$ 18,000	3,200	Cubic Yards	$ 20	$ 64,000	106,000	Cubic Yards	$
isposal (Class 2 Non-Hazardous)	10,500	Tons	$ 80	$ 840,000	1,350	Tons	$ 80	$ 108,000	4,800	Tons	$ 80	$ 384,000	159,000	Tons	$
al Monitoring	23	Days	$ 1,800	$ 41,400	3	Days	$ 1,800	$ 5,400	11	Days	$ 1,800	$ 19,800	348	Days	$
	11.6	Acres	$ 9,900	$ 114,840	0.8	Acres	$ 9,900	$ 7,920	1.2	Acres	$ 9,900	$ 11,880	26	Acres	$
	8.7	Acres	$ 50,000	$ 435,000	0.6	Acres	$ 50,000	$ 30,000	0.9	Acres	$ 50,000	$ 45,000	20	Acres	$
	1	Lump Sum	$ 50,000	$ 50,000	1	Lump Sum	$ 50,000	$ 50,000	1	Lump Sum	$ 50,000	$ 50,000	1	Lump Sum	$
	1	10% of subtotal	$ 228,764	$ 229,000	1	10% of subtotal	$ 47,772	$ 48,000	1	10% of subtotal	$ 97,348	$ 98,000	1	10% of subtotal	$
				$ 2,516,640				**$ 525,720**				**$ 1,071,480**			
													In-situ Soil Mixing		
													106,000 cy in-situ soil mixing, res restoration		
and oversight (10% of Construction)													1	Lump Sum	$
													1	Lump Sum	$
zation													1	Lump Sum	$
													106,000	Cubic Yards	$
													26	Acres	$
													26	Acres	$
													1	Lump Sum	$
													1	Lump Sum	$
an													1	Lump Sum	$
													1	10% of subtotal	$

ed on available AOC data. Most probable estimates of affected areas were utilized for costing; however, actual costs may increase/decrease based on further characterization efforts. Costs are assumed to be within the -30%, +50% range over 30 years using a discount rate of 9% and an inflation rate of 2%.
l. If existing pond remains a pond or wetland after alternative is implemented, the existing structure was counted as part of the mitigation (i.e., create new wetland area equal to three times the pond area to achieve 4:1 mitigation). In this scenario, the pond area would require reseeding but not the effort to create new wetland area, and therefore wa
m. If the existing pond will not remain after the alternative is implemented, create new wetland area equal to four times the pond area to achieve 4:1 mitigation. In the case of Pond 8 institutional controls, minor wetlands in former concrete tanks along the north berm and the seeps and beach below the crib wall are affected.

assumed for the wet vegetative cover alternatives. This replacement rate is based on sediment cap replacement in areas of active water flow and likely sediment cover scour and transport.

echnologies Screening Matrix and Reference Guide, Version 4.0 (https://frtr.gov/matrix2/top_page.html).

Fort Bragg, California

	IRM and West of IRM AOC			Lowland AOC		
Nature and Extent	• Fuel-related constituents • 20,000 sf impacted groundwater aerial extent • <15 foot depth interval			• Barium • 20,000 sf impacted groundwater aerial extent • <30 foot depth interval		
Remediation Alternative Cost Estimates and Assumptions	Number of Years	Unit Cost/Typical Annual Cost	NPV Cost	Number of Years	Unit Cost/Typical Annual Cost	NPV C
No Action						
Assumptions:	No remediation activities required			No remediation activities required		
Net Present Value			**$ -**			**$**
Restricted Use						
Assumptions:	Additional delineation, deed restriction, survey and risk management plan			Additional delineation, deed restriction, survey and risk mar plan		
Delineation and survey, deed restriction	1	$ 26,000	$ 26,000	1	$ 26,000	$
Risk management plan	1	$ 39,000	$ 39,000	1	$ 39,000	$
Net Present Value			**$ 65,000**			**$**
Monitored Natural Attenuation						
Assumptions: Based on 2017 groundwater monitoring costs, NPV	Monitoring/reporting for 5 wells every 5 years for 30 years (6 events $5,800 + $1,100 each), NPV			Monitoring/reporting for 1 well every 5 years for 30 years (6 $1,900 + $400 each), NPV		
Semi-annual monitoring and reporting cost	6	$ 5,800	$ 13,000	6	$ 1,900	$
Laboratory Analysis Cost	6	$ 1,100	$ 3,000	6	$ 400	$
Delineation and survey, deed restriction	1	$ 26,000	$ 26,000	1	$ 26,000	$
Net Present Value			**$ 42,000**			**$**
Enhanced Aerobic Bioremediation: 2 Events + MNA						
Assumptions:	Injection of Calcium Peroxide, 2 events, 25% plume coverage, 10 years MNA					
Design, coordination, preparation (10% of implementation cost)	1	-	$ 14,400			
Well installation	1	-	$ 53,600			
Injection event	2	$ 45,000	$ 90,000			
Performance monitoring + MNA	10	$ 6,900	$ 53,000			
Net Present Value			**$ 211,000**			
Enhanced Anaerobic Bioremediation: 2 Events + MNA						
Assumptions:	Injection of Magnesium Sulfate (Epsom Salts) in source area , 2 events, 25% plume coverage, 10 years MNA					
Design, coordination, preparation (10% of implementation cost)	1	-	$ 13,500			
Well installation	1	-	$ 53,600			
Injection event	2	$ 41,000	$ 81,000			
Performance monitoring + MNA	10	$ 6,900	$ 53,000			
Net Present Value			**$ 201,100**			

olume estimates were based on available AOC data. Most probable estimates of affected areas were utilized for costing; however, actual costs may rease based on further characterization efforts. Costs are assumed to be within the -30%, +50% range.

ates are based on a 9% discount rate and a 2% inflation rate starting with 2018 as "year zero".

Appendix B

OU-E Remedial Investigation Tables 4-51, 4-52, and 4-53,
Sediment Statistical Summaries

Table 4-51
Sediment Statistical Summary
Pond 8

Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent	Units	Number of Detects	Number of Samples	Detection Frequency %	Range of Detections			Location of Maximum Detection	Arithmetic Mean	Number of Exceedances / Number of Samples		Exceedances Above Background/ Total Exceedances [h]
										HH PSL [e]	Eco PSL [f]	
Metals												
Antimony	mg/kg	45	56	80%	0.12	-	2.5	SD-5.1,DP-04.14	0.846	0/56	0/56	NA
Arsenic	mg/kg	56	56	100%	0.58	-	27.6	Pond08-04	8.55	56/56	19/56	19/56
Barium	mg/kg	56	56	100%	33.5	-	2170	Pond08-01	475	0/56	0/56	NA
Beryllium	mg/kg	49	56	88%	0.191	-	0.95	DP-05.62	0.56	0/56	0/56	NA
Cadmium	mg/kg	39	56	70%	0.048	-	1.94	Pond08-08	0.713	0/56	19/56	0/19
Chromium (hexavalent compounds)	mg/kg	0	21	0%	NA	-	NA	NA	0.025	0/21	0/21	0/21
Chromium	mg/kg	56	56	100%	6.9	-	65.6	Pond08-10	34.6	0/56	18/56	4/18
Cobalt	mg/kg	56	56	100%	1.9	-	20.3	Pond08-11	11.1	0/56	1/56	1/1
Copper	mg/kg	56	56	100%	0.52	-	251	Pond08-04	85.8	0/56	39/56	34/39
Lead	mg/kg	56	56	100%	1.9	-	302	Pond08-07	56.7	13/56	27/56	27/27
Mercury	mg/kg	53	56	95%	0.021	-	0.305	Pond08-17	0.106	0/56	10/56	10/10
Molybdenum	mg/kg	51	56	91%	0.13	-	96.4	Pond08-04	9.83	0/56	24/56	20/24
Nickel	mg/kg	56	56	100%	6.35	-	52.4	Pond08-18	29.8	0/56	38/56	13/38
Selenium	mg/kg	30	56	54%	0.4	-	2.3	Pond08-04	0.799	0/56	0/56	NA
Silver	mg/kg	32	56	57%	0.058	-	0.526	Pond08-03	0.215	0/56	0/56	NA
Thallium	mg/kg	32	56	57%	0.035	-	0.34	Pond08-09	0.171	0/56	0/56	NA
Vanadium	mg/kg	56	56	100%	9.8	-	103	Pond08-18	50.9	0/56	0/56	NA
Zinc	mg/kg	56	56	100%	9.4	-	675	Pond08-08	238	0/56	31/56	30/31
Total Petroleum Hydrocarbons (TPH)												
Gasoline C6-C8	mg/kg	0	19	0%	NA	-	NA	NA	0.0999	0/19	NA	NA
Gasoline C8-C10	mg/kg	0	19	0%	NA	-	NA	NA	0.0999	0/19	NA	NA
Total Gasoline (C6-C10)[1]	mg/kg	0	19	0%	NA	-	NA	NA	NA	0/19	NA	NA
Diesel C10-C12	mg/kg	47	60	78%	1.7	-	6700	Pond08-08	491	33/60	NA	NA
Diesel C12-C16	mg/kg	52	60	87%	2.4	-	7100	Pond08-08	697	13/60	NA	NA
Diesel C16-C24	mg/kg	58	60	97%	1.3	-	25000	Pond8-17 (re-extracted)	3060	5/60	NA	NA
Total Diesel (C10-C24)[2]	mg/kg	58	60	97%	1.3	-	36900	Pond8-17 (re-extracted)	4390	8/60	34/60	NA
Motor Oil C24-C36	mg/kg	55	60	92%	11	-	22000	Pond08-08	4650	0/60	NA	NA
Polychlorinated Biphenyls (PCB)												
PCB #8	mg/kg	5	23	22%	0.00037	-	0.0027	Pond08-06	0.000685	0/23	0/23	NA
PCB #18	mg/kg	6	23	26%	0.00097	-	0.008	Pond08-06	0.00117	0/23	0/23	NA
PCB #28	mg/kg	11	23	48%	0.00055	-	0.014	Pond08-06	0.00207	0/23	0/23	NA
PCB #44	mg/kg	9	23	39%	0.00048	-	0.0061	Pond08-06	0.00105	0/23	0/23	NA

Table 4-51
Sediment Statistical Summary
Pond 8

Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent	Units	Number of Detects	Number of Samples	Detection Frequency %	Range of Detections			Location of Maximum Detection	Arithmetic Mean	Number of Exceedances / Number of Samples		Exceedances Above Background/ Total Exceedances [h]
										HH PSL [e]	Eco PSL [f]	
PCB #52	mg/kg	7	23	30%	0.00074	-	0.0057	Pond08-06	0.00115	0/23	0/23	NA
PCB #66	mg/kg	8	23	35%	0.0003	-	0.0039	Pond08-06	0.000793	0/23	0/23	NA
PCB #77	mg/kg	1	23	4%	0.00035	-	0.00035	DP-05.62	0.000439	0/23	0/23	NA
PCB #81	mg/kg	6	23	26%	0.00087	-	0.011	Pond08-06	0.00172	0/23	0/23	NA
PCB #101	mg/kg	2	23	9%	0.0039	-	0.004	Pond08-03	0.00102	0/23	0/23	NA
PCB #105	mg/kg	8	23	35%	0.00046	-	0.0017	Pond08-08	0.000615	0/23	0/23	NA
PCB #118	mg/kg	10	23	44%	0.00071	-	0.0045	Pond08-08	0.00102	0/23	0/23	NA
PCB #128	mg/kg	7	23	30%	0.00034	-	0.0011	Pond08-06	0.000465	0/23	0/23	NA
PCB #138	mg/kg	13	23	57%	0.00025	-	0.0045	Pond08-06	0.00106	0/23	0/23	NA
PCB #153	mg/kg	8	23	35%	0.00048	-	0.0068	Pond08-06	0.00119	0/23	0/23	NA
PCB #156	mg/kg	7	23	30%	0.0003	-	0.0015	Pond08-08	0.000507	0/23	0/23	NA
PCB #169	mg/kg	4	23	17%	0.00044	-	0.00095	Pond08-08	0.000473	4/23	0/23	NA
PCB #170	mg/kg	5	23	22%	0.00055	-	0.0014	Pond08-06	0.000501	0/23	0/23	NA
PCB #180	mg/kg	11	23	48%	0.00022	-	0.0035	Pond08-06	0.000894	0/23	0/23	NA
PCB #187	mg/kg	5	23	22%	0.00095	-	0.002	Pond08-06	0.000632	0/23	0/23	NA
PCB #206	mg/kg	8	23	35%	0.00027	-	0.0011	Pond08-06	0.000512	0/23	0/23	NA
PCB #209	mg/kg	1	23	4%	0.00034	-	0.00034	Pond08-06	0.000417	0/23	0/23	NA
Total PCB Congeners[6]	mg/kg	19.000	23.000	83%	0.001	-	0.150	Pond08-06	0.028	0/23	2/23	NA
Polycyclic Aromatic Hydrocarbons (PAH)												
2-Methylnaphthalene	mg/kg	15	15	100%	0.012	-	0.24	Pond08-06	0.0717	0/15	11/15	NA
Acenaphthene	mg/kg	15	39	39%	0.0037	-	0.067	Pond08-06	0.071	0/39	13/39	NA
Acenaphthylene	mg/kg	17	39	44%	0.0089	-	0.45	Pond08-03	0.0893	0/39	17/39	NA
Anthracene	mg/kg	15	39	39%	0.012	-	0.3	Pond08-03	0.0729	0/39	8/39	NA
Benzo(a)anthracene	mg/kg	16	39	41%	0.031	-	1.1	Pond08-07	0.164	8/39	10/39	NA
Benzo(a)pyrene	mg/kg	16	39	41%	0.021	-	1.7	Pond08-07	0.191	15/39	10/39	NA
Benzo(b)fluoranthene	mg/kg	16	39	41%	0.034	-	2.5	Pond08-07	0.265	10/39	0/39	NA
Benzo(g,h,i)perylene	mg/kg	16	39	41%	0.066	-	1.9	Pond08-07	0.23	0/39	10/39	NA
Benzo(k)fluoranthene	mg/kg	15	39	39%	0.014	-	0.77	Pond08-07	0.114	1/39	3/39	NA
Chrysene	mg/kg	20	39	51%	0.047	-	1.9	Pond08-07	0.224	0/39	10/39	NA
Dibenz(a,h)anthracene	mg/kg	15	39	39%	0.0083	-	0.4	Pond08-07	0.0831	8/39	8/39	NA
Dibenzofuran	mg/kg	15	15	100%	0.017	-	0.38	Pond08-03	0.0898	0/15	0/15	NA
Fluoranthene	mg/kg	20	39	51%	0.027	-	2.8	Pond08-03	0.463	0/39	11/39	NA
Fluorene	mg/kg	20	39	51%	0.015	-	0.26	Pond08-06	0.0956	0/39	5/39	NA

Table 4-51
Sediment Statistical Summary
Pond 8

Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent	Units	Number of Detects	Number of Samples	Detection Frequency %	Range of Detections			Location of Maximum Detection	Arithmetic Mean	Number of Exceedances / Number of Samples		Exceedances Above Background/ Total Exceedances [h]
										HH PSL [e]	Eco PSL [f]	
Indeno(1,2,3-cd)Pyrene	mg/kg	15	39	39%	0.036	-	2	Pond08-07	0.218	9/39	7/39	NA
Naphthalene	mg/kg	17	39	44%	0.039	-	1.3	Pond08-03	0.201	0/39	9/39	NA
Phenanthrene	mg/kg	24	39	62%	0.053	-	1.8	Pond08-03	0.348	0/39	18/39	NA
Pyrene	mg/kg	21	39	54%	0.031	-	2.9	Pond08-07	0.518	0/39	14/39	NA
LMW-PAH[10]	mg/kg	24	39	62%	0.053	-	4.7	Pond08-03	1	0/39	0/39	NA
HMW-PAH[11]	mg/kg	22	39	56%	0.05	-	18	Pond08-07	3.49	0/39	0/39	NA
Total PAH[3]	mg/kg	24	39	62%	0.11	-	9.3	Pond08-08,Pond08-03	2.51	0/39	11/39	NA
USEPA B(a)P TEQ[4]	mg/kg	20	39	51%	0.00047	-	2.8	Pond08-07	0.466	15/39	12/39	NA
Volatile Organic Compounds (VOC)												
2-Butanone	mg/kg	16	20	80%	0.00069	-	0.0087	DP-05.61	0.00244	0/20	0/20	NA
Acetone	mg/kg	19	20	95%	0.003	-	0.026	DP-05.61	0.0102	0/20	7/20	NA
Benzene	mg/kg	1	20	5%	0.00059	-	0.00059	DP-05.60	0.000162	0/20	0/20	NA
Carbon Disulfide	mg/kg	0	19	0%	NA	-		NA	0.000674	0/19	0/19	NA
Chlorobenzene	mg/kg	5	20	25%	0.00026	-	0.0011	DP-05.61,DP-04.14	0.000328	0/20	0/20	NA
Ethanol	mg/kg	0	19	0%	NA	-	NA	NA	0.0253	0/19	0/19	NA
Isopropyl alcohol	mg/kg	0	19	0%	NA	-	NA	NA	0.00389	0/19	0/19	NA
Isopropylbenzene	mg/kg	0	19	0%	NA	-	NA	NA	0.000185	0/19	0/19	NA
Methylene Chloride	mg/kg	7	20	35%	0.00041	-	0.0011	DP-05.61	0.000721	0/20	0/20	NA
p-Isopropyl Toluene	mg/kg	0	19	0%	NA	-	NA	NA	0.000226	0/19	0/19	NA
Naphthalene	mg/kg	0	19	0%	NA	-	NA	NA	0.0153	0/19	0/19	NA
Toluene	mg/kg	17	20	85%	0.00035	-	0.0033	DP-05.61	0.00107	0/20	0/20	NA
Dioxins/Furans												
2,3,7,8-TCDD TEQ (Human/Mammal)[7]	pg/g	45	45	100%	0.00029	-	231	Pond08-17	83.5	38/45	36/45	NA
2,3,7,8-TCDD TEQ (Bird)[8]	pg/g	45	45	100%	9.5E-05	-	362	DP-05.61	93.5	0/45	37/45	NA
2,3,7,8-TCDD TEQ (Fish)[9]	pg/g	44	45	98%	0.001	-	194	DP-05.61	70.7	0/45	35/45	NA
2,3,7,8-TCDD	pg/g	40	45	89%	0.218	-	28.5	Pond08-07	7.56	31/45	0/45	NA
1,2,3,7,8-PeCDD	pg/g	42	45	93%	0.223	-	85.7	Pond08-17	22.8	0/45	0/45	NA
1,2,3,4,7,8-HxCDD	pg/g	42	45	93%	0.16	-	78.9	Pond08-06	28.4	0/45	0/45	NA
1,2,3,6,7,8-HxCDD	pg/g	42	45	93%	0.387	-	301	Pond08-17	101	21/45	0/45	NA

Table 4-51
Sediment Statistical Summary
Pond 8

Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent	Units	Number of Detects	Number of Samples	Detection Frequency %	Range of Detections			Location of Maximum Detection	Arithmetic Mean	Number of Exceedances / Number of Samples		Exceedances Above Background/ Total Exceedances [h]
										HH PSL [e]	Eco PSL [f]	
1,2,3,7,8,9-HxCDD	pg/g	42	45	93%	0.524	-	234	Pond08-07	68.8	15/45	0/45	NA
1,2,3,4,6,7,8-HpCDD	pg/g	44	45	98%	0.237	-	4420	Pond08-07,Pond08-18	1220	0/45	0/45	NA
OCDD	pg/g	45	45	100%	0.95	-	36400	Pond08-18	8410	0/45	0/45	NA
2,3,7,8-TCDF	pg/g	43	45	96%	0.0903	-	129	Pond08-01	22.7	0/45	0/45	NA
1,2,3,7,8-PeCDF	pg/g	41	45	91%	0.103	-	37.2	Pond08-04	10	0/45	0/45	NA
2,3,4,7,8-PeCDF	pg/g	42	45	93%	0.252	-	315	DP-05.61	17.7	0/45	0/45	NA
1,2,3,4,7,8-HxCDF	pg/g	40	45	89%	0.136	-	59.8	Pond08-18	17	0/45	0/45	NA
1,2,3,6,7,8-HxCDF	pg/g	42	45	93%	0.134	-	65.8	Pond08-18	22.7	0/45	0/45	NA
2,3,4,6,7,8-HxCDF	pg/g	41	45	91%	0.205	-	122	DP-05.61	25.4	0/45	0/45	NA
1,2,3,7,8,9-HxCDF	pg/g	40	45	89%	0.265	-	15.8	DP-05.61	5.5	0/45	0/45	NA
1,2,3,4,6,7,8-HpCDF	pg/g	44	45	98%	0.0476	-	2040	Pond08-18	311	0/45	0/45	NA
1,2,3,4,7,8,9-HpCDF	pg/g	42	45	93%	0.114	-	118	Pond08-18	18.8	0/45	0/45	NA
OCDF	pg/g	43	45	96%	0.362	-	8450	Pond08-18	1080	0/45	0/45	NA
Total TCDD	pg/g	42	45	93%	0.384	-	188	Pond08-04	60	0/45	0/45	NA
Total PeCDD	pg/g	42	45	93%	0.913	-	302	Pond08-17	102	0/45	0/45	NA
Total HxCDD	pg/g	44	45	98%	0.147	-	2450	Pond08-07	631	0/45	0/45	NA
Total HpCDD	pg/g	44	45	98%	0.41	-	7870	Pond08-18	2220	0/45	0/45	NA
Total TCDF	pg/g	43	45	96%	1.39	-	1760	DP-05.61	409	0/45	0/45	NA
Total PeCDF	pg/g	44	45	98%	0.159	-	4180	DP-05.61	376	0/45	0/45	NA
Total HxCDF	pg/g	44	45	98%	0.166	-	1830	Pond08-18	500	0/45	0/45	NA
Total HpCDF	pg/g	44	45	98%	0.0923	-	6230	Pond08-18	916	0/45	0/45	NA
Pesticides												
4,4'-DDD	mg/kg	4	6	67%	0.0032	-	0.013	Pond08-07	0.00495	0/6	2/6	NA
4,4'-DDE	mg/kg	4	6	67%	0.002	-	0.0055	Pond08-08	0.00305	0/6	2/6	NA
Aldrin	mg/kg	1	6	17%	0.00059	-	0.00059	Pond08-08	0.00102	0/6	0/6	NA
Alpha-BHC	mg/kg	1	6	17%	0.0011	-	0.0011	Pond08-08	0.00111	0/6	0/6	NA
Alpha-Chlordane	mg/kg	4	6	67%	0.0023	-	0.0048	Pond08-08	0.00293	0/6	0/6	NA
Dieldrin	mg/kg	1	6	17%	0.0023	-	0.0023	Pond08-07	0.00162	0/6	1/6	NA
Endosulfan I	mg/kg	1	6	17%	0.0012	-	0.0012	Pond08-08	0.00113	0/6	0/6	NA
Endrin Aldehyde	mg/kg	1	6	17%	0.0013	-	0.0013	Pond08-08	0.00114	0/6	0/6	NA
Gamma-Chlordane	mg/kg	5	6	83%	0.00058	-	0.0072	Pond08-07	0.00324	0/6	0/6	NA
Heptachlor Epoxide	mg/kg	1	6	17%	0.00035	-	0.00035	Pond08-07	0.000917	0/6	0/6	NA
Heptachlor	mg/kg	1	6	17%	0.0015	-	0.0015	Pond08-08	0.00113	0/6	1/6	NA

Table 4-52
Sediment Statistical Summary
North Pond and Ponds 6 and 7

Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent	Units	Number of Detects	Number of Samples	Detection Frequency %	Range of Detections			Location of Maximum Detection	Arithmetic Mean	Number of Exceedances / Number of Samples		Exceedances Above Background/ Total Exceedances [h]
										HH PSL [e]	Eco PSL [f]	
Metals												
Antimony	mg/kg	28	40	70%	0.37	-	3.1	Pond7-02	0.758	0/40	0/40	NA
Arsenic	mg/kg	40	40	100%	0.33	-	115	Pond7-02	19.8	40/40	18/40	17/40
Barium	mg/kg	40	40	100%	28	-	3220	Pond6-02	733	0/40	0/40	NA
Beryllium	mg/kg	24	40	60%	0.25	-	0.842	Pond6-02,Pond7-02	0.354	0/40	0/40	NA
Cadmium	mg/kg	19	40	48%	0.274	-	4.29	Pond7-02	0.871	0/40	11/40	4/11
Chromium (hexavalent compounds)	mg/kg	1	24	4%	0.23	-	0.23	DP-4.7	0.0335	0/24	0/24	NA
Chromium	mg/kg	40	40	100%	4.5	-	86.7	Pond7-02	29.4	0/40	10/40	5/10
Cobalt	mg/kg	40	40	100%	0.67	-	16.9	Pond7-02	7.41	0/40	0/40	NA
Copper	mg/kg	40	40	100%	0.71	-	234	Pond7-01	50.3	0/40	17/40	14/17
Lead	mg/kg	40	40	100%	0.98	-	262	Pond7-02	47.4	7/40	11/40	11/11
Mercury	mg/kg	29	40	73%	0.022	-	0.742	Pond7-01	0.135	0/40	9/40	9/9
Molybdenum	mg/kg	33	40	83%	0.26	-	14.7	North Pond-01	2.4	0/40	11/40	7/11
Nickel	mg/kg	40	40	100%	2.8	-	44.7	Pond7-02	19.1	0/40	13/40	3/13
Selenium	mg/kg	7	40	18%	0.6	-	1	North Pond-01,Pond7-02	0.382	0/40	0/40	NA
Silver	mg/kg	11	40	28%	0.172	-	0.786	Pond7-02	0.212	0/40	0/40	NA
Thallium	mg/kg	11	40	28%	0.113	-	0.743	Pond7-02	0.211	0/40	0/40	NA
Vanadium	mg/kg	40	40	100%	7.9	-	59.2	North Pond-01	30.8	0/40	0/40	NA
Zinc	mg/kg	40	40	100%	9.6	-	1180	Pond7-02	242	0/40	17/40	16/17
Total Petroleum Hydrocarbons (TPH)												
Gasoline C6-C8	mg/kg	0	27	0%	NA	-	NA	NA	0.105	0/27	NA	NA
Gasoline C8-C10	mg/kg	0	27	0%	NA	-	NA	NA	0.105	0/27	NA	NA
Total Gasoline (C6-C10)[1]	mg/kg	0	27	0%	NA	-	NA	NA		0/27	NA	NA
Diesel C10-C12	mg/kg	17	37	46%	1.1	-	260	Pond07-02	22.6	0/37	NA	NA
Diesel C12-C16	mg/kg	20	37	54%	1.5	-	260	Pond07-02	36.2	0/37	NA	NA
Diesel C16-C24	mg/kg	31	37	84%	1.1	-	1100	Pond07-02	212	0/37	NA	NA
Total Diesel (C10-C24)[2]	mg/kg	31	37	84%	1.1	-	1620	Pond07-02	307	0/37	3/37	NA
Motor Oil C24-C36	mg/kg	28	37	76%	6.1	-	1900	Pond07-01,Pond07-02,Pond07-02	448	0/37	NA	NA
Polycyclic Aromatic Hydrocarbons (PAH)												
2-Methylnaphthalene	mg/kg	9	11	82%	0.0088	-	0.098	Pond07-02	0.0437	0/11	7/11	NA
Acenaphthene	mg/kg	12	38	32%	0.0033	-	0.13	DP-04.12	0.0418	0/38	9/38	NA
Acenaphthylene	mg/kg	16	38	42%	0.0024	-	1.1	DP-04.12	0.159	0/38	15/38	NA
Anthracene	mg/kg	12	38	32%	0.005	-	0.19	Pond07-01	0.0487	0/38	7/38	NA
Benzo(a)anthracene	mg/kg	15	38	40%	0.01	-	0.16	Pond07-02	0.0467	1/38	5/38	NA
Benzo(a)pyrene	mg/kg	11	38	29%	0.0073	-	0.24	Pond07-02	0.0505	7/38	5/38	NA
Benzo(b)fluoranthene	mg/kg	17	38	45%	0.0059	-	0.29	Pond07-02	0.0654	5/38	0/38	NA
Benzo(g,h,i)perylene	mg/kg	9	38	24%	0.018	-	0.3	Pond07-01,Pond07-02	0.0637	0/38	5/38	NA
Benzo(k)fluoranthene	mg/kg	10	38	26%	0.008	-	0.082	Pond07-02	0.0348	0/38	0/38	NA
Chrysene	mg/kg	16	38	42%	0.01	-	0.17	Pond07-02	0.0556	0/38	1/38	NA

Table 4-52
Sediment Statistical Summary
North Pond and Ponds 6 and 7

Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent	Units	Number of Detects	Number of Samples	Detection Frequency %	Range of Detections			Location of Maximum Detection	Arithmetic Mean	Number of Exceedances / Number of Samples		Exceedances Above Background/ Total Exceedances [h]
										HH PSL [e]	Eco PSL [f]	
Dibenz(a,h)anthracene	mg/kg	8	38	21%	0.0051	-	0.013	Pond07-01,Pond07-02	0.025	0/38	0/38	NA
Dibenzofuran	mg/kg	9	11	82%	0.0026	-	0.45	Pond06-02	0.192	0/11	0/11	NA
Fluoranthene	mg/kg	21	38	55%	0.0053	-	1.2	DP-04.11	0.267	0/38	9/38	NA
Fluorene	mg/kg	14	38	37%	0.0026	-	0.25	DP-04.12	0.0593	0/38	9/38	NA
Indeno(1,2,3-cd)Pyrene	mg/kg	9	38	24%	0.016	-	0.24	Pond07-01,Pond07-02	0.0575	5/38	3/38	NA
Naphthalene	mg/kg	17	38	45%	0.0085	-	3	DP-04.12	0.509	0/38	14/38	NA
Phenanthrene	mg/kg	21	38	55%	0.015	-	1.3	DP-04.11	0.297	0/38	13/38	NA
Pyrene	mg/kg	21	38	55%	0.0069	-	1.3	DP-04.11	0.277	0/38	13/38	NA
LMW-PAH[10]	mg/kg	21.0	38.0	55%	0.0	-	5.7	DP-04.12	1.9	0/38	0/38	NA
HMW-PAH[11]	mg/kg	21.0	38.0	55%	0.0	-	3.4	Pond07-02	1.3	0/38	0/38	NA
Total PAH[3]	mg/kg	21.00	38.00	55%	0.03	-	4.20	Pond07-02	1.77	0/38	9/38	NA
USEPA B(a)P TEQ[4]	mg/kg	17	38	45%	0.00059	-	0.33	Pond07-02	0.101	7/38	5/38	NA
Volatile Organic Compounds (VOC)												
2-Butanone	mg/kg	12	27	44%	0.00044	-	0.003	DP-04.10	0.00118	0/27	0/27	NA
Acetone	mg/kg	20	27	74%	0.0023	-	0.011	DP-04.09	0.00464	0/27	1/27	NA
Benzene	mg/kg	0	19	0%	NA	-	NA	NA	0.000172	0/19	0/19	NA
Carbon Disulfide	mg/kg	0	19	0%	NA	-	NA	NA	0.00107	0/19	0/19	NA
Chlorobenzene	mg/kg	5	27	19%	0.00049	-	0.002	DP-04.09	0.000368	0/27	0/27	NA
Ethanol	mg/kg	2	27	7%	0.016	-	0.23	DP-04.09	0.0448	0/27	0/27	NA
Isopropyl alcohol	mg/kg	1	27	4%	0.003	-	0.003	DP-04.09	0.00707	0/27	0/27	NA
Isopropylbenzene	mg/kg	1	27	4%	0.00048	-	0.00048	DP-04.07	0.000255	0/27	0/27	NA
Methylene Chloride	mg/kg	6	27	22%	0.00056	-	0.00083	DP-04.08	0.000693	0/27	0/27	NA
p-Isopropyl Toluene	mg/kg	1	27	4%	0.0036	-	0.0036	DP-04.07	0.000376	0/27	0/27	NA
Naphthalene	mg/kg	0	19	0%	NA	-	NA	NA	0.00684	0/19	0/19	NA
Toluene	mg/kg	17	27	63%	0.00034	-	0.0023	DP-04.10	0.000669	0/27	0/27	NA
Dioxins/Furans												
2,3,7,8-TCDD TEQ (Human/Mammal)[7]	pg/g	27	27	100%	0.023	-	1688	Pond07-02	505	21/27	18/27	NA
2,3,7,8-TCDD TEQ (Bird)[8]	pg/g	27	27	100%	0	-	3668	Pond07-02	1180	0/27	19/27	NA
2,3,7,8-TCDD TEQ (Fish)[9]	pg/g	27	27	100%	0	-	1848	Pond07-02	562	0/27	18/27	NA
2,3,7,8-TCDD	pg/g	22	27	82%	0.253	-	273	Pond07-02	81	18/27	0/27	NA
1,2,3,7,8-PeCDD	pg/g	23	27	85%	0.421	-	519	Pond07-02	146	0/27	0/27	NA
1,2,3,4,7,8-HxCDD	pg/g	22	27	82%	0.325	-	506	Pond07-02	122	9/27	0/27	NA
1,2,3,6,7,8-HxCDD	pg/g	24	27	89%	0.168	-	760	Pond07-02	189	9/27	0/27	NA
1,2,3,7,8,9-HxCDD	pg/g	24	27	89%	0.119	-	604	Pond07-02	149	9/27	0/27	NA
1,2,3,4,6,7,8-HpCDD	pg/g	26	27	96%	0.294	-	3150	Pond07-02	786	0/27	0/27	NA
OCDD	pg/g	27	27	100%	0.722	-	5450	Pond07-02	1700	0/27	0/27	NA
2,3,7,8-TCDF	pg/g	26	27	96%	0.224	-	1600	Pond07-02	508	0/27	0/27	NA
1,2,3,7,8-PeCDF	pg/g	23	27	85%	0.227	-	921	Pond07-02	266	0/27	0/27	NA
2,3,4,7,8-PeCDF	pg/g	24	27	89%	0.352	-	1190	DP-04.12	329	0/27	0/27	NA

Table 4-52
Sediment Statistical Summary
North Pond and Ponds 6 and 7

Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent	Units	Number of Detects	Number of Samples	Detection Frequency %	Range of Detections			Location of Maximum Detection	Arithmetic Mean	Number of Exceedances / Number of Samples		Exceedances Above Background/ Total Exceedances [h]
										HH PSL [e]	Eco PSL [f]	
1,2,3,4,7,8-HxCDF	pg/g	24	27	89%	0.0841	-	595	Pond07-02	160	0/27	0/27	NA
1,2,3,6,7,8-HxCDF	pg/g	25	27	93%	0.0728	-	684	Pond07-02	185	0/27	0/27	NA
2,3,4,6,7,8-HxCDF	pg/g	24	27	89%	0.0826	-	854	Pond07-02	227	0/27	0/27	NA
1,2,3,7,8,9-HxCDF	pg/g	21	27	78%	0.161	-	251	Pond07-02	64.5	0/27	0/27	NA
1,2,3,4,6,7,8-HpCDF	pg/g	25	27	93%	0.288	-	886	Pond07-02	231	0/27	0/27	NA
1,2,3,4,7,8,9-HpCDF	pg/g	22	27	82%	0.383	-	203	Pond07-02	52.8	0/27	0/27	NA
OCDF	pg/g	25	27	93%	0.603	-	348	Pond07-02	117	0/27	0/27	NA
Total TCDD	pg/g	25	27	93%	0.177	-	9450	Pond07-02	2460	0/27	0/27	NA
Total PeCDD	pg/g	25	27	93%	0.122	-	8070	Pond07-02	2120	0/27	0/27	NA
Total HxCDD	pg/g	25	27	93%	1	-	10400	Pond07-02	2530	0/27	0/27	NA
Total HpCDD	pg/g	26	27	96%	0.5	-	5740	Pond07-02	1430	0/27	0/27	NA
Total TCDF	pg/g	27	27	100%	0.147	-	32800	Pond07-02	9810	0/27	0/27	NA
Total PeCDF	pg/g	26	27	96%	0.0906	-	16000	Pond07-02	4490	0/27	0/27	NA
Total HxCDF	pg/g	26	27	96%	0.0798	-	6690	Pond07-02	1790	0/27	0/27	NA
Total HpCDF	pg/g	25	27	93%	0.565	-	1800	Pond07-02	479	0/27	0/27	NA

Table 4-53
Sediment Statistical Summary
Southern Ponds

Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent	Units	Number of Detects	Number of Samples	Detection Frequency %	Range of Detections			Location of Maximum Detection	Arithmetic Mean	Number of Exceedances / Number of Samples		Exceedances Above Background/ Total Exceedances [h]
										HH PSL [e]	Eco PSL [f]	
Metals												
Antimony	mg/kg	44	47	94%	0.05	-	4.7	DP-07.13,DP-07.15	1.62	0/47	0/47	NA
Arsenic	mg/kg	47	47	100%	1.66	-	98.9	Pond03-01	19.3	47/47	23/47	23/47
Barium	mg/kg	47	47	100%	23	-	5240	Pond03-07	1530	1/47	0/47	1/1
Beryllium	mg/kg	43	47	92%	0.21	-	1.15	Pond02-01	0.615	0/47	0/47	NA
Cadmium	mg/kg	28	47	60%	0.22	-	5	Pond03-01	1.31	0/47	18/47	9/18
Chromium (hexavalent compounds)	mg/kg	2	23	9%	0.06	-	0.11	DP-07.11	0.0302	0/23	0/23	NA
Chromium	mg/kg	47	47	100%	8	-	94.5	Pond03-01	40.2	0/47	19/47	9/19
Cobalt	mg/kg	47	47	100%	2.1	-	30.4	Pond03-09	12.6	0/47	8/47	8/8
Copper	mg/kg	47	47	100%	1.6	-	240	Pond02-02	72.7	0/47	24/47	22/24
Lead	mg/kg	47	47	100%	1.3	-	389	Pond01-02	53.5	9/47	17/47	17/17
Mercury	mg/kg	44	47	94%	0.021	-	0.419	Pond03-01	0.0889	0/47	4/47	4/4
Molybdenum	mg/kg	44	47	94%	0.29	-	67.1	Pond03-09	6.76	0/47	21/47	17/21
Nickel	mg/kg	47	47	100%	8.21	-	61.5	Pond03-09	27.3	0/47	29/47	8/29
Selenium	mg/kg	21	47	45%	0.39	-	5.7	Pond03-09	1.09	0/47	0/47	NA
Silver	mg/kg	23	47	49%	0.081	-	0.799	Pond02-01	0.266	0/47	0/47	NA
Thallium	mg/kg	24	47	51%	0.042	-	1.39	Pond01-02	0.335	0/47	0/47	NA
Vanadium	mg/kg	47	47	100%	11	-	113	Pond03-09	51.9	0/47	0/47	NA
Zinc	mg/kg	47	47	100%	12	-	1510	Pond03-01	356	0/47	22/47	21/22
Total Petroleum Hydrocarbons (TPH)												
Gasoline C6-C8	mg/kg	NA	NA	0%	NA	-	NA	NA	NA	NA	NA	NA
Gasoline C8-C10	mg/kg	NA	NA	0%	NA	-	NA	NA	NA	NA	NA	NA
Total Gasoline (C6-C10)[1]	mg/kg	NA	NA	0%	NA	-	NA	NA	NA	NA	NA	NA
Diesel C10-C12	mg/kg	20	40	50%	1.6	-	160	Pond03-02	19.7	4/40	NA	NA
Diesel C12-C16	mg/kg	24	40	60%	1.1	-	100	Pond03-02	16.6	0/40	NA	NA
Diesel C16-C24	mg/kg	35	40	88%	1	-	1400	Pond03-02	189	0/40	NA	NA
Total Diesel (C10-C24)[2]	mg/kg	35	40	88%	1	-	1660	Pond03-02	252	0/40	2/40	NA
Motor Oil C24-C36	mg/kg	32	40	80%	7.3	-	4100	Pond03-02	581	0/40	NA	NA
Polychlorinated Biphenyls (PCB)												
PCB #8	mg/kg	3	27	11%	0.0004	-	0.0011	DP-07.13	0.000541	0/27	0/27	NA
PCB #18	mg/kg	0	27	0%	NA	-	NA	NA	0.000414	0/27	0/27	NA
PCB #28	mg/kg	3	27	11%	0.00054	-	0.00061	DP-07.14	0.000425	0/27	0/27	NA
PCB #44	mg/kg	0	27	0%	NA	-	NA	NA	0.000414	0/27	0/27	NA
PCB #52	mg/kg	0	27	0%	NA	-	NA	NA	0.000442	0/27	0/27	NA
PCB #66	mg/kg	0	27	0%	NA	-	NA	NA	0.000414	0/27	0/27	NA

Table 4-53
Sediment Statistical Summary
Southern Ponds

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Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent	Units	Number of Detects	Number of Samples	Detection Frequency %	Range of Detections			Location of Maximum Detection	Arithmetic Mean	Number of Exceedances / Number of Samples		Exceedances Above Background/ Total Exceedances [h]
										HH PSL [e]	Eco PSL [f]	
PCB #77	mg/kg	0	27	0%	NA	-	NA	NA	0.000414	0/27	0/27	NA
PCB #81	mg/kg	0	27	0%	NA	-	NA	NA	0.000414	0/27	0/27	NA
PCB #101	mg/kg	0	27	0%	NA	-	NA	NA	0.000414	0/27	0/27	NA
PCB #105	mg/kg	0	27	0%	NA	-	NA	NA	0.000438	0/27	0/27	NA
PCB #118	mg/kg	1	27	4%	0.0011	-	0.0011	DP-07.13	0.000449	0/27	0/27	NA
PCB #128	mg/kg	0	27	0%	NA	-	NA	NA	0.000414	0/27	0/27	NA
PCB #138	mg/kg	3	27	11%	0.00031	-	0.00051	Pond03-02	0.00039	0/27	0/27	NA
PCB #153	mg/kg	2	27	7%	0.00043	-	0.00091	Pond03-02	0.000419	0/27	0/27	NA
PCB #156	mg/kg	0	27	0%	NA	-	NA	NA	0.000414	0/27	0/27	NA
PCB #169	mg/kg	0	27	0%	NA	-	NA	NA	0.000414	0/27	0/27	NA
PCB #170	mg/kg	0	27	0%	NA	-	NA	NA	0.000414	0/27	0/27	NA
PCB #180	mg/kg	4	27	15%	0.00049	-	0.00088	Pond03-05	0.00044	0/27	0/27	NA
PCB #187	mg/kg	0	27	0%	NA	-	NA	NA	0.000414	0/27	0/27	NA
PCB #206	mg/kg	0	27	0%	NA	-	NA	NA	0.000414	0/27	0/27	NA
PCB #209	mg/kg	0	27	0%	NA	-	NA	NA	0.000414	0/27	0/27	NA
Total PCB Congeners[6]	mg/kg	7	27	26%	0.0011	-	0.0056	Pond03-02	0.00296	0/27	0/27	NA
Polycyclic Aromatic Hydrocarbons (PAH)												
2-Methylnaphthalene	mg/kg	17	17	100%	0.0033	-	0.5	Pond02-02	0.0594	0/17	12/17	NA
Acenaphthene	mg/kg	17	40	43%	0.00073	-	0.29	Pond02-02	0.0583	0/40	12/40	NA
Acenaphthylene	mg/kg	21	40	53%	0.0071	-	3.4	Pond02-02	0.218	0/40	21/40	NA
Anthracene	mg/kg	19	40	48%	0.0034	-	1.3	Pond02-02	0.105	0/40	9/40	NA
Benzo(a)anthracene	mg/kg	19	40	48%	0.0058	-	1.1	Pond02-02	0.13	5/40	10/40	NA
Benzo(a)pyrene	mg/kg	20	40	50%	0.0077	-	1.6	Pond02-02	0.14	16/40	10/40	NA
Benzo(b)fluoranthene	mg/kg	22	40	55%	0.01	-	1.9	Pond02-02	0.175	10/40	0/40	NA
Benzo(g,h,i)perylene	mg/kg	17	40	43%	0.014	-	2.6	Pond02-02	0.178	0/40	9/40	NA
Benzo(k)fluoranthene	mg/kg	19	40	48%	0.0032	-	0.82	DP-07.13	0.0922	2/40	2/40	NA
Chrysene	mg/kg	24	40	60%	0.0068	-	1.4	DP-07.13	0.167	0/40	8/40	NA
Dibenz(a,h)anthracene	mg/kg	17	40	43%	0.00097	-	0.15	Pond02-02	0.0483	5/40	2/40	NA
Dibenzofuran	mg/kg	17	17	100%	0.01	-	1.8	Pond02-02	0.246	0/17	0/17	NA
Fluoranthene	mg/kg	29	40	73%	0.0067	-	7.8	Pond02-02	0.808	0/40	14/40	NA
Fluorene	mg/kg	18	40	45%	0.0017	-	0.99	Pond02-02	0.0989	0/40	7/40	NA
Indeno(1,2,3-cd)Pyrene	mg/kg	17	40	43%	0.013	-	2	Pond02-02	0.159	9/40	5/40	NA
Naphthalene	mg/kg	24	40	60%	0.015	-	12	Pond02-02	0.732	1/40	19/40	NA
Phenanthrene	mg/kg	28	40	70%	0.012	-	8.3	Pond02-02	0.678	0/40	18/40	NA
Pyrene	mg/kg	30	40	75%	0.006	-	7.5	Pond02-02	0.796	0/40	17/40	NA

Table 4-53
Sediment Statistical Summary
Southern Ponds

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Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent	Units	Number of Detects	Number of Samples	Detection Frequency %	Range of Detections			Location of Maximum Detection	Arithmetic Mean	Number of Exceedances / Number of Samples		Exceedances Above Background/ Total Exceedances [h]
										HH PSL [e]	Eco PSL [f]	
LMW-PAH[10]	mg/kg	29.000	40.000	73%	0.012	-	28.600	Pond02-02	2.580	0/40	0/40	NA
HMW-PAH[11]	mg/kg	30.00	40.00	75%	0.02	-	26.60	Pond02-02	3.23	0/40	0/40	NA
Total PAH[3]	mg/kg	30	40	75%	0.022	-	33	Pond02-02	3.5	0/40	14/40	NA
USEPA B(a)P TEQ[4]	mg/kg	24.000	40.000	60%	0.001	-	2.300	Pond02-02	0.275	16/40	10/40	NA
Volatile Organic Compounds (VOC)												
2-Butanone	mg/kg	10	21	48%	0.0012	-	0.0051	DP-07.13	0.00142	0/21	0/21	NA
Acetone	mg/kg	20	21	95%	0.00099	-	0.2	DP-07.13	0.0159	0/21	7/21	NA
Benzene	mg/kg	1	21	5%	0.00028	-	0.00028	DP-07.11	0.000165	0/21	0/21	NA
Carbon Disulfide	mg/kg	1	21	5%	0.00039	-	0.00039	DP-07.15	0.000791	0/21	0/21	NA
Chlorobenzene	mg/kg	10	21	48%	0.00021	-	0.0039	DP-07.09	0.000992	0/21	0/21	NA
Ethanol	mg/kg	2	21	10%	0.19	-	5.4	DP-07.13	0.288	0/21	0/21	NA
Isopropyl alcohol	mg/kg	1	21	5%	0.5	-	0.5	DP-07.13	0.0279	0/21	0/21	NA
Isopropylbenzene	mg/kg	0	21	0%	NA	-	NA	NA	0.000204	0/21	0/21	NA
Methylene Chloride	mg/kg	7	21	33%	0.00067	-	0.0012	DP-07.17	0.000715	0/21	0/21	NA
p-Isopropyl Toluene	mg/kg	0	21	0%	NA	-	NA	NA	0.000245	0/21	0/21	NA
Naphthalene	mg/kg	1	21	5%	0.00056	-	0.00056	DP-07.15	0.000266	0/21	0/21	NA
Toluene	mg/kg	4	21	19%	0.00022	-	0.00076	DP-07.10	0.000221	0/21	0/21	NA
Dioxins/Furans												
2,3,7,8-TCDD TEQ (Human/Mammal)[7]	pg/g	36	39	92%	0.02	-	1285	Pond03-01	180	31/39	28/39	NA
2,3,7,8-TCDD TEQ (Bird)[8]	pg/g	36	39	92%	0.016	-	2793	Pond03-01	477	0/39	30/39	NA
2,3,7,8-TCDD TEQ (Fish)[9]	pg/g	36	39	92%	0.016	-	1392	Pond03-01	189	0/39	28/39	NA
2,3,7,8- TCDD	pg/g	34	39	87%	0.22	-	186	Pond03-01	32.2	28/39	0/39	NA
1,2,3,7,8- PeCDD	pg/g	33	39	85%	0.462	-	379	Pond03-01	39.7	0/39	0/39	NA
1,2,3,4,7,8- HxCDD	pg/g	33	39	85%	0.338	-	397	Pond03-01	34.2	4/39	0/39	NA
1,2,3,6,7,8- HxCDD	pg/g	34	39	87%	0.231	-	670	Pond03-01	66.5	5/39	0/39	NA
1,2,3,7,8,9- HxCDD	pg/g	32	39	82%	0.419	-	508	Pond03-01	48.3	4/39	0/39	NA
1,2,3,4,6,7,8- HpCDD	pg/g	36	39	92%	0.41	-	2760	Pond03-01	380	0/39	0/39	NA
OCDD	pg/g	36	39	92%	1.66	-	17900	Pond03-09	1660	0/39	0/39	NA
2,3,7,8- TCDF	pg/g	35	39	90%	0.299	-	1240	Pond03-01	237	0/39	0/39	NA
1,2,3,7,8-PeCDF	pg/g	34	39	87%	0.841	-	668	Pond03-01	99.5	0/39	0/39	NA
2,3,4,7,8-PeCDF	pg/g	34	39	87%	1.03	-	645	Pond03-01	92.6	0/39	0/39	NA
1,2,3,4,7,8-HxCDF	pg/g	33	39	85%	0.45	-	467	Pond03-01	47.8	0/39	0/39	NA
1,2,3,6,7,8-HxCDF	pg/g	34	39	87%	0.3	-	525	Pond03-01	58.4	0/39	0/39	NA
2,3,4,6,7,8-HxCDF	pg/g	35	39	90%	0.125	-	691	Pond03-01	70.5	0/39	0/39	NA

Table 4-53
Sediment Statistical Summary
Southern Ponds

Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent	Units	Number of Detects	Number of Samples	Detection Frequency %	Range of Detections			Location of Maximum Detection	Arithmetic Mean	Number of Exceedances / Number of Samples		Exceedances Above Background/ Total Exceedances [h]
										HH PSL [e]	Eco PSL [f]	
1,2,3,7,8,9-HxCDF	pg/g	33	39	85%	0.281	-	179	Pond03-01	20.2	0/39	0/39	NA
1,2,3,4,6,7,8-HpCDF	pg/g	36	39	92%	0.195	-	781	Pond03-01	101	0/39	0/39	NA
1,2,3,4,7,8,9-HpCDF	pg/g	31	39	80%	0.211	-	178	Pond03-01	19	0/39	0/39	NA
OCDF	pg/g	34	39	87%	0.61	-	1500	Pond03-09	130	0/39	0/39	NA
Total TCDD	pg/g	34	39	87%	3.77	-	7690	Pond03-01	737	0/39	0/39	NA
Total PeCDD	pg/g	34	39	87%	1.77	-	6780	Pond03-01	546	0/39	0/39	NA
Total HxCDD	pg/g	34	39	87%	1.93	-	9460	Pond03-01	777	0/39	0/39	NA
Total HpCDD	pg/g	36	39	92%	0.773	-	5040	Pond03-01	669	0/39	0/39	NA
Total TCDF	pg/g	36	39	92%	0.177	-	24100	Pond03-01	3860	0/39	0/39	NA
Total PeCDF	pg/g	34	39	87%	8.93	-	11800	Pond03-01	1510	0/39	0/39	NA
Total HxCDF	pg/g	35	39	90%	0.284	-	5300	Pond03-01	593	0/39	0/39	NA
Total HpCDF	pg/g	36	39	92%	0.195	-	1630	Pond03-01	235	0/39	0/39	NA

Appendix C

OU-E Remedial Investigation Appendix D,
Selection of Screening Level Values for Data Evaluation

ARCADIS

Appendix D

Selection of Screening Level Values for Data Evaluation

Charts

Tables

Figures

Introduction

This appendix summarizes the approach used to determine appropriate screening levels for evaluation of constituents of interest (COIs) in soil, sediment, surface water and groundwater within the Operable Unit E (OU-E) area at the former Georgia-Pacific Wood Products Facility in Fort Bragg, California (site). The methodology used for screening level selection was consistent with the approach presented in previous reports, including:

- Site Wide Risk Assessment Work Plan (ARCADIS BBL, 2008a)
- Remedial Investigation Report, Operable Unit A (ARCADIS BBL, 2008b)
- Data Summary Report – Operable Unit E Pond Sediment (ARCADIS, 2009)
- Site Investigation Work Plan Operable Unit E (ARCADIS, 2010a)
- Remedial Investigation Report, Operable Units C and D (ARCADIS, 2011a)
- Fourth Quarter 2009 Groundwater Monitoring Report (ARCADIS, 2010b)

Evaluation of Soil Screening Levels

Background Concentrations of Inorganic Chemicals in Soil

In accordance with guidance from the U.S. Environmental Protection Agency (USEPA, 2002) and the California Department of Toxic Substances Control (DTSC, 1997), 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 concentrations at a given site are not considered constituents of potential concern (COPCs). Lithology-specific background concentrations for metals in soil were established for the site by ARCADIS BBL (2007) following DTSC guidance and using data from samples collected within the site. These site background concentrations for metals are presented in Table D-1. A detailed description of the method is provided in the Background Metals Report (ARCADIS BBL, 2007). Note that the background concentration for lead was specified by DTSC (2008).

Concentrations of metals detected in soil samples were compared first to site background concentrations and then to screening levels. Background concentrations for some metals are close to or higher than the human health and ecological screening levels; in these cases, metals were only considered potential COIs and evaluated accordingly if concentrations exceeded the background concentrations. If the metal concentrations exceed the screening levels but are less than lithology-specific background concentrations, concentrations were assumed to be naturally occurring.

Soil Screening Levels for Human Health Evaluation

The following sources of screening levels were used to evaluate concentrations of COIs relative to screening concentrations developed for protection of human health. These sources are listed according to the hierarchy in which they were applied.

1. Site-specific background concentrations for metals (ARCADIS BBL, 2007)

2. California Human Health Screening Levels (CHHSLs) established by the California Environmental Protection Agency (CalEPA; 2005)[1]

3. Regional Screening Levels (RSLs) for residential soil (USEPA, 2010), incorporating DTSC (2009b) recommendations in Human Health Risk Assessment (HHRA) Note 3 regarding the use of RSLs and DTSC's recommendation to use the more conservative of the latest RSL update and HHRA Note 3 recommended values (DTSC, 2010)

4. Site-specific risk-based screening concentrations (RBSCs) for total petroleum hydrocarbons (TPH; ARCADIS BBL, 2008b) for direct contact and indoor air, and site-specific TPH screening levels for the leaching to groundwater pathway (ARCADIS, 2010c).

5. Suggested soil remediation goal for residential land use in California based on dioxin toxic equivalent (TEQ) analysis (DTSC, 2009a)

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[1] Note that there are some exceptions to the CHHSL: DTSC has recommended the use of the USEPA RSLs for PCBs; additionally, for cadmium the CHHSL has been recalculated to reflect the current toxicity assessment by the Office of Environmental Health Hazard Assessment (OEHHA, 2011). The recalculation is based on cadmium as carcinogen only via the inhalation route. The recalculated CHHSL for cadmium is 39 mg/kg and is actually based on the non-cancer endpoint.

The Remedial Investigation Report for OU-E utilizes screening levels recommended by DTSC for screening purposes. The soil data were first screened against CHHSLs (CalEPA, 2005). If no CHHSL was available, data were screened against the USEPA Region 9 RSLs for residential exposure (USEPA, 2010) using alternate values, such as the (California-modified) Preliminary Remediation Goal or (California-modified) RSL for selected analytes, as specified by DTSC in HHRA Note 3 (DTSC, 2009b). These screening levels are shown in Table D-1; for ease of discussion, the screening level used for evaluation for each COI is called the “primary screening level”. As described above, metals data were first screened against the site-specific background concentrations presented in Table D-1.

PCBs

RSLs have been developed for low risk (i.e., Aroclor® 1016) and high risk (i.e., Aroclor® 1254) Aroclor mixtures. Based on the Aroclor data available for the site, most of the polychlorinated biphenyls (PCBs) detected fall into the high risk category; therefore, the screening value of 0.22 milligrams per kilogram (mg/kg) was compared to sample data for total PCB concentrations.

PCB congeners analyzed in samples from the site were chosen based on the National Oceanic and Atmospheric Administration (NOAA) National Status and Trends list of congeners. Eighteen congeners from the list were included; NOAA had identified these congeners as representative of the chlorination levels in all congeners and as representative of congeners typically detected in the environment. In addition, 10 coplanar congeners from the NOAA list were included; NOAA had identified these congeners as not abundant in the environment.

NOAA has developed an algorithm to express the relationship of the sum of the 18 congeners representative of congeners typically detected in the environment to the sum of Aroclors; the algorithm returns a factor of approximately 2.3. Therefore, as previously discussed and agreed upon with the agencies (ARCADIS BBL, 2008b), for comparability between Aroclor-based screening levels and congener analyses, the PCB congeners analyzed in samples from the sitewere summed and multiplied by 2 to obtain a total PCB concentration (NOAA, 2000).

PAHs

Carcinogenic PAHs were evaluated by calculating the benzo(a)pyrene (B[a]P) TEQ and comparing it to the primary screening level (i.e., the CHHSL) for B(a)P. The B(a)P

TEQ was calculated using the toxicity equivalence factors (TEFs) presented in Part II of the California Office of Environmental Health Hazard Assessment (OEHHA) Air Toxics Hot Spots Program Risk Assessment Guidelines (OEHHA, 2005), plus the TEF for dibenzo(a,h)anthracene presented in the Region IV Guidance for polycyclic aromatic hydrocarbon (PAH) toxicity assessment (USEPA, 2000a). This PAH is not included in the OEHHA list of chemicals to include in the B(a)P TEQ calculation. Inclusion of this PAH in the TEQ calculation is a conservative approach.

Similarly, dioxins/furans were evaluated based on the detected concentrations of dioxin and by calculating 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) TEQs for humans/mammals using the World Health Organization (WHO) 2005 TEFs for these receptors (Van den Berg et al., 2006). The dioxin results and the 2,3,7,8-TCDD TEQs for humans/mammals were compared to the DTSC 2,3,7,8-TCDD TEQ-suggested residential remediation goals for mitigation sites in California (California Dioxin Remediation Goal [CDRG]).

Consideration of November 2011 Regional Screening Levels

In November 2011, subsequent to the initial submittal of the May 2011 Draft OU-E Report, another iteration of the RSLs was published by the USEPA (USEPA, 2011). These recent revisions to the RSLs were evaluated to determine potential impacts on PSLs selected for characterization of nature and extent of impacts in OU-E. As summarized in the table below, ten of the 2010 RSLs considered in the OU-E RI were revised as of November 2011. For thallium and n-butylbenzene, the PSLs used in the OU-E RI would not be affected, since the PSLs were based on either CHHSLs or DTSC (2009b) recommendations in Human Health Risk Assessment (HHRA) Note 3 regarding the use of RSLs. The consideration of the 2011 RSL changes for 1,2-dichloropropane and bromoform would result in a higher PSL, but does not impact the characterization, since neither of these analytes were detected in soil (Section 4 data tables). Updated RSLs for six constituents (4-chlorotoluene, bromochloromethane, dichlorodifluoromethane, trichloroethene, o-xylenes, and hexachloroethane) would result in the selection of lower primary screening values. However, this does not impact the nature and extent characterization because all six analytes were either not detected, or only detected at concentrations well below the November 2011 RSL (see Chart 1 below and Section 4 data tables). In summary, the updated November 2011 RSLs would not generate additional PSL exceedances and do not impact the characterization of soil in OU-E.

Chart 1 Updated Soil RSLs For Site Analytes (November 2011 vs November 2010)

Compound	CAS No.	Units	USEPA Nov 2011 RSL	USEPA Nov 2010 RSL	Comments
No Change to PSL					
Thallium	7440-28-0	mg/kg	0.78	--	Current PSL based on CHHSL
n-Butylbenzene	104-51-8	mg/kg	3900	--	Current PSL based on DTSC HERD Note 3 value of 240 mg/kg (2004 PRG)
Increased PSL					
1,2-Dichloropropane	78-87-5	mg/kg	0.94	0.89	PSL based on 2010 RSL. Both analytes not detected.
Bromoform	75-25-2	mg/kg	62	61	
New or Decreased PSL					
4-Chlorotoluene	106-43-4	mg/kg	1600	5500	PSL based on 2010 RSL. Analyte not detected.
Bromochloromethane	74-97-5	mg/kg	160	--	No PSL since no previous RSL or HERD Note 3 recommendation. Analyte not detected.
Dichloro-difluoromethane	75-71-8	mg/kg	94	180	PSL based on 2010 RSL. Analyte not detected.
Trichloroethene	79-01-6	mg/kg	0.91	2.8	PSL based on 2010 RSL. Analyte not detected.
Xylenes, o-	95-47-6	mg/kg	690	3800	PSL based on 2010 RSL. Analyte not detected above 0.0021 mg/kg.
Hexachloroethane	67-72-1	mg/kg	12	35	PSL based on 2010 RSL. Analyte not detected.

SL = screening level

Soil Screening Levels for Ecological Evaluation

Because OU-E will likely be used as a recreational and habitat area in the future, detected COIs were also evaluated relative to conservative direct-contact plant phytotoxicity and invertebrate benchmarks, and wildlife (avian and mammalian) ecological soil screening levels (EcoSSLs;USEPA, 2007f). For each COI, the lowest of the invertebrate contact benchmark, plant contact toxicity benchmark, and wildlife EcoSSLs was considered the “primary screening level” for ecological evaluation of soil impacts. The majority of plant toxicity benchmarks were taken from Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process (Efroymson et al. 1997a) or Toxicological

Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants (Efroymson et al. 1997b), except for the constituents noted in Table D-2. Benchmarks for some constituents were also taken from the USEPA EcoSSLs for invertebrates (USEPA, 2007f) and the Canadian Soil Quality Guidelines for Protection of the Environment and Human Health (2006). Additionally, ecological benchmarks were compared to site-specific background concentrations for metals in soil as presented in Table D-1. In the event that the most restrictive ecological benchmark was below background concentrations, the background concentration was considered the primary screening level as noted in Table D-2.

To evaluate the potential cumulative effects of detected PAHs on ecological receptors, total concentrations of low molecular weight (LMW) and high molecular weight (HMW) PAHs were calculated for each sample and compared to USEPA EcoSSLs for invertebrates and wildlife. The total concentration of LMW PAHs was calculated by summing the detected concentrations of naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphtene, flourene, phenanthrene, and anthracene. The total concentration of HMW PAHs was calculated by summing the detected concentrations of fluoranthene, pyrene, benzo(a)anthracene, chrysene, B(a)P, dibenz(a,h)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, and ideno(1,2,3-cd)pyrene.

Evaluation of Sediment Screening Levels

Sediment Background Evaluation

A substantial number of sediment samples have been collected from the OU-E ponds. A background study for sediment metals concentrations has not been conducted for the site. As described previously, most ponds at the site, except Ponds 5 and 9, have received wastewater from site operations, and Pond 8 also receives stormwater from the City. Ponds 5 and 9 store water for fire suppression and are filled primarily by water pumped from Pudding Creek. Pond 5 may receive some surface runoff from the site and areas east of the site, but the berm around Pond 9 likely prevents runoff from flowing into it. However, Pudding Creek receives significant runoff containing typical stormwater contaminants such as copper, chromium, lead, nickel, and zinc. These metals find their way into runoff from streets as a result of particulates deposited from vehicle wear (they are present in vehicle undercoatings, tires, and brake linings) and erosion of concrete and asphalt materials (Pitt and Voorhees, 2000). As all the ponds at the site are man-made, the sediment present in them is derived mainly from site soil.

Because there has been no industrial wastewater inputs into Ponds 5 and 9, they may be representative of background or ambient concentrations of metals in site ponds.

Site-specific background concentrations for metals have been established for 17 metals in soil (ARCADIS BBL, 2007); however, site-specific background concentrations for metals have not been established for sediment. Nevertheless, soil background concentrations may be informative in evaluation of site sediment concentrations since pond sediments likely originated from site soils. Soil background values are considered a conservative representation of sediment background concentrations. Generally, metals associated with fine-grained materials accumulate in sediment depositional areas. As a result of this process, sediment background concentrations are generally higher than soil background concentrations from the same general area. To determine if the soil background concentrations are applicable to sediment, the following evaluation was conducted:

- Pond sediment data for each metal were separated into two datasets:
  - Data from Ponds 5 and 9 only, which did not receive wastewater from site operations
  - Data from all other ponds, collectively referred to as “OUE Ponds”
- Summary statistics were compiled for each dataset for each metal (frequency of detection, minimum, maximum, mean, median, and other statistics)
- Both data sets were graphed in box plot form for comparison to each other and to the soil background concentrations for fill (F) and marine sediment/bedrock (MSB).

The summary statistics and box plots are presented in Figures D-1 through D-18. (Hexavalent chromium [Chromium VI] is presented in Figure D-7, however, a soil background concentration has not been established.)

Examination of the figures reveals the following:

- All detected sediment concentrations of beryllium in all ponds are less than soil background concentrations.
- All detected sediment concentrations of arsenic, cadmium, chromium (total), cobalt, nickel, thallium, and vanadium in Ponds 5 and 9 are less than soil background concentrations.
- All detected sediment concentrations of antimony, barium, mercury, and selenium in Ponds 5 and 9 except outliers are less than soil background concentrations.

- Some detected sediment concentrations of molybdenum and zinc in Ponds 5 and 9 are greater than soil background concentrations.
  - Molybdenum: One extreme outlier exists within the F background concentration; most concentrations are less than the lower MSB background concentration.
  - Zinc: Two concentrations slightly exceed the F background concentration; a few exceed the lower MSB background concentration.
- Many sediment concentrations of copper and lead in Ponds 5 and 9 exceed soil background concentrations and are distributed similarly the OU-E Ponds.
  - Copper: The concentration range in Ponds 5 and 9 is wider than the range in the OU-E Ponds.
  - Lead: The concentration range in the OU-E Ponds is wider than the range in Ponds 5 and 9.
- All but one of the detected silver concentrations in Ponds 5 and 9 are below the soil background concentration. The reporting limit for most samples collected before 2008 (0.25 mg/kg) is slightly higher than the soil background value of 0.22 mg/kg; therefore, nondetects plot slightly above the soil background value on Figure D-15.
- Chromium VI was not detected above the reporting limit of 0.05 mg/kg within the nine samples collected from Ponds 5 and 9. In samples collected from OU-E Ponds, Chromium VI was detected in only three of 68 samples tested; concentrations ranged from 0.06 mg/kg to 0.23 mg/kg.

These observations indicate that the site-specific soil background concentrations at the site are useful for comparison to sediment concentrations of most metals tested in ponds in OU-E. Concentrations in Ponds 5 and 9 are generally similar to or lower than soil background concentrations. Sediment concentrations in Ponds 5 and 9 appear representative of background or ambient concentrations for OU-E Ponds sediments, having generally smaller concentration ranges and lower median concentrations than the OU-E Ponds data for each metal. Copper and lead concentrations in several samples from Pond 5 and 9 exceed soil background concentrations, but these metals are common stormwater contaminants and increased concentrations could be a result of runoff from Pudding Creek. Copper and lead may be enriched in some OU-E Pond sediments due to direct stormwater runoff.

Sediment Screening Levels for Ecological Evaluation

Sediment data were compared to ecological benchmarks for freshwater sediment, as presented in the Site Wide Risk Assessment Work Plan (ARCADIS BBL, 2008a) and Table D-3. These benchmarks are primarily based on “consensus based threshold effects concentrations” (TEC) and “consensus-based probable effects concentrations” (PEC) taken from MacDonald et al. (2000), except where noted in Table D-1. For example, the screening values for dioxins are taken from the Canadian Council of Ministers of the Environment (CCME) Sediment Quality Guidelines for the Protection of Aquatic Life: Summary Tables (2002), which include Interim freshwater sediment quality guidelines (ISQGs) and Probable Effects Levels (PELs). For simplicity, the ecological benchmarks are referred to as PEC and TEC in this report, but original sources are documented in Table D-3.

The TCDD TEQ for birds and the TCDD TEQ for fish were compared to the ecological screening levels only. The ecological screening levels presented in the Site Wide Risk Assessment Work Plan (ARCADIS BBL, 2008a) and selected for use in this data evaluation are those derived by the CCME (2001; 2002). The CCME screening levels are “numerical concentrations that are set with the intention to protect all forms of aquatic life and all aspects of their aquatic life cycles during an indefinite period of exposure to substances associated with bed sediments” (CCME, 2001). The screening levels were developed based on response of benthic communities to concentrations of dioxins/furans in sediment, expressed as TEQ for fish and calculated using the WHO 2005 TEF (Van den Berg et al., 2006). However, the CCME screening levels for dioxins/furans are well within the range of sediment quality guidelines proposed by the USEPA to protect wildlife including birds, mammals, and fish (Wenning and Martello, 2004; Iannuzzi et al., 1995). Therefore, the comparison of the CCME screening levels to the calculated TCDD TEQ for birds and mammals, as well as fish, is justified and may be considered a conservative indication of potential effects. The ISQG value of 0.85 picograms per gram (pg/g) is considered a highly conservative value as it is well below background conditions. The PEL, therefore, is considered a more reliable screening value, although it also may be within background conditions.

Concentrations of TPH in sediment were compared to site-specific RBSCs and site specific screening concentrations for leaching of TPH to groundwater for soil, as described below.

The analytical results were also compared to human health screening levels for soil recommended by DTSC. However, this comparison is for discussion purposes only, as the screening levels are for soil and residential use, but pond data is aquatic sediment and the future use of OU-E will most likely be recreational. Therefore, the use of residential exposure assumptions for aquatic sediments is overly conservative.

Evaluation of Groundwater Screening Levels

For groundwater, two methods of selecting groundwater screening levels were used. The first focused on identifying a “primary screening level” or PSL, which used the following sources of screening levels listed according to the hierarchy in which they were applied:

1. The more conservative of federal and state maximum contaminant levels (MCLs; USEPA, 2006b)

2. Public Health Goals (PHGs; OEHHA, 2006)

3. RSLs for tap water (RSL-tw; USEPA, 2010), incorporating DTSC (2009b) recommendations in HHRA Note 3 regarding the use of RSLs and DTSC’s recommendation to use the more conservative of the latest RSL update and HHRA Note 3 recommended values (DTSC, 2010)

4. Alternative screening levels from the Central Valley Region Water Quality Control Board (CVRWQCB, 2007) and/or provided in a letter from the North Coast Region Water Quality Control Board (NCRWQCB, 2010)

5. Site-specific RBSCs for TPH (ARCADIS BBL, 2008a)

6. CVRWQCB TPH water quality objectives (WQOs) for taste and odor (2004).

A second set of screening levels, referred to as “RWQCB WQOs,” was developed following the hierarchy outlined in *A Compilation of Water Quality Goals* (CalEPA, 2011). This hierarchy includes:

1. Selecting a chemical constituent’s objective as the lowest value between the state and federal MCLs, Water Quality Control Plan numerical objectives, and agricultural use limits

2. Selecting a toxicity objective according to a listed hierarchy of preferred values

3. Selecting a taste and odor objective according to a listed hierarchy of preferred values

4. Selecting the lowest limit for the three values selected as described above

The screening levels for groundwater are presented in Tables D-4 and D-5. Background concentrations for metals in groundwater are also available for screening purposes and are provided in Table D-4. Data was screened against both the PSL and the RWQCB WQO. PSLs are focused on promulgated values such as MCLs, which are derived from health-based criteria; PSL also include technologic and economic considerations (CVRWQCB, 2007) and are also listed as WQOs in the NCRWQCB *Water Quality Control Plan for the North Coast Region* (NCRWQCB, 2007). The RWQCB WQOs, on the other hand, are derived from a number of sources, not all promulgated values, and include some values that could be outdated (such as the National Academy of Sciences [NAS] Suggested No-Adverse-Response-Levels [SNARLs], which were published in documents dating from 1977 to 1989; NAS 1980) and other values that may not be applicable to groundwater at the site (such as the USEPA water quality advisories, some of which include criteria for protection of aquatic life or are based on shellfish harvesting). Additionally, many of the RWQCB WQOs are below laboratory detection limits and/or background levels for metals.

The values described above are compared to data from both monitoring wells and groundwater grab samples. It should be recognized that data from groundwater grab samples may overestimate concentrations significantly due to the inability to develop temporary sampling points as you would a monitoring well (e.g., there is usually higher turbidity/particulates). Data from permanent monitoring wells are always preferred for decision-making. Additionally, more recent monitoring well data are preferred over data from older sampling events.

Consideration of November 2011 Regional Screening Levels

The November 2011 updates to the USEPA RSLs were evaluated to determine potential impacts on groundwater PSLs selected for OU-E. As summarized in the table below, a total of 119 of the 2010 RSLs considered in the OU-E RI were revised as of November 2011. For 59 of these analytes, the primary screening value used in the OU-E RI would not be affected, since the PSL values were based on either MCLs or DTSC (2009b) recommendations in HHRA Note 3 regarding the use of RSLs. The consideration of the 2011 RSL changes for the other 61 analytes would result in the selection of lower primary groundwater screening values. However, this does not impact the nature and extent characterization because 60 of these 61 analytes were either not detected, or only detected at concentrations well below the November 2011 RSL (see Chart 2 below and Section 4 data tables). One analyte, cobalt, was detected above the November 2011 RSL in 2 out of 45 grab samples. Detected cobalt concentrations in all monitoring well groundwater samples are below the November 2011 RSL (total of 135 monitoring well samples were collected for cobalt analysis). In summary, the updated November 2011 RSLs would not generate PSL exceedances that impact the characterization of groundwater in OU-E.

Chart 2 Updated Groundwater RSLs for Site Analytes (November 2011 vs November 2010)

Compound	CAS No.	Units	USEPA 2011 RSL	USEPA 2010 RSL	Comment
No Change to PSL					
Aluminum (fume or dust)	7429-90-5	µg/L	16000	37000	Current PSL based on MCL
Antimony	7440-36-0	µg/L	6	15	Current PSL based on MCL
Barium	7440-39-3	µg/L	2900	7300	Current PSL based on MCL
Beryllium	7440-41-7	µg/L	16	73	Current PSL based on MCL
Cadmium	7440-43-9	µg/L	6.9	18	Current PSL based on MCL
Chromium	7440-47-3	µg/L	16000	55000	Current PSL based on MCL
Copper	7440-50-8	µg/L	620	1500	Current PSL based on MCL
Iron	7439-89-6	µg/L	11000	26000	Current PSL based on MCL
Manganese (non-diet)	7439-96-5	µg/L	320	880	Current PSL based on MCL
Mercury	7439-97-6	µg/L	4.3	11	Current PSL based on MCL
Nickel	7440-02-0	µg/L	300	730	Current PSL based on MCL
Selenium	7782-49-2	µg/L	78	180	Current PSL based on MCL
Silver	7440-22-4	µg/L	71	180	Current PSL based on MCL
Thallium	7440-28-0	µg/L	0.16	--	Current PSL based on MCL
Zinc	7440-66-6	µg/L	4700	11000	Current PSL based on MCL
1,1,1-Trichloroethane	71-55-6	µg/L	7500	9100	Current PSL based on MCL
1,1,2,2-Tetrachloroethane	79-34-5	µg/L	0.066	0.067	Current PSL based on MCL
1,1-Dichloroethene	75-35-4	µg/L	260	340	Current PSL based on MCL
1,2,4-Trichlorobenzene	120-82-1	µg/L	0.99	2.3	Current PSL based on MCL
1,2-Dichlorobenzene	95-50-1	µg/L	280	370	Current PSL based on MCL

Compound	CAS No.	Units	USEPA 2011 RSL	USEPA 2010 RSL	Comment
1,2-Dichloropropane	78-87-5	µg/L	0.38	0.39	Current PSL based on MCL
1,4-Dichlorobenzene	106-46-7	µg/L	0.42	0.43	Current PSL based on MCL
2-Chlorotoluene	95-49-8	µg/L	730	180	PSL based on HERD Note 3 value of 120
Benzene	71-43-2	µg/L	0.39	0.41	Current PSL based on MCL
Bromochloromethane	74-97-5	µg/L	83	--	Current PSL based on MCL
Bromoform	75-25-2	µg/L	7.9	8.5	Current PSL based on MCL
Carbon Tetrachloride	56-23-5	µg/L	0.39	0.44	Current PSL based on MCL
Chlorinated Fluorocarbon (freon 113)	76-13-1	µg/L	53000	59000	Current PSL based on MCL
Chlorobenzene	108-90-7	µg/L	72	91	Current PSL based on MCL
cis-1,2-Dichloroethene	156-59-2	µg/L	28	73	Current PSL based on MCL
Ethylbenzene	100-41-4	µg/L	1.3	1.5	Current PSL based on MCL
m,p-Xylenes	1330-20-7	µg/L	190	200	Current PSL based on MCL
Methylene Chloride	75-09-2	µg/L	4.7	4.8	Current PSL based on MCL
n-butylbenzene	104-51-8	µg/L	280	--	PSL based on HERD Note 3 value of 240
n-propylbenzene	103-65-1	µg/L	530	1300	PSL based on HERD Note 3 value of 240
o-xylene	95-47-6	µg/L	190	1200	Current PSL based on MCL
Styrene	100-42-5	µg/L	1100	1600	Current PSL based on MCL
Tetrachloroethene	127-18-4	µg/L	0.072	0.11	Current PSL based on MCL
Toluene	108-88-3	µg/L	860	2300	Current PSL based on MCL
trans-1,2-Dichloroethene	156-60-5	µg/L	86	110	Current PSL based on MCL
trans-1,3-Dichloropropene	10061-02-6	µg/L	0.41	0.43	Current PSL based on PHG of 0.2
Trichloroethene	79-01-6	µg/L	0.44	2	Current PSL based on MCL
Trichlorofluoromethane (freon 11)	75-69-4	µg/L	1100	1300	Current PSL based on MCL
Vinyl Chloride	75-01-4	µg/L	0.015	0.016	Current PSL based on MCL
Xylenes, Total	1330-20-7	µg/L	190	200	Current PSL based on MCL
Acenaphthalene	83-32-9	µg/L	400	2200	PSL based on HERD Note 3 value of 370

Compound	CAS No.	Units	USEPA 2011 RSL	USEPA 2010 RSL	Comment
2-Chloronaphthalene	91-58-7	µg/L	550	2900	PSL based on HERD Note 3 value of 490
2-Chlorophenol	95-57-8	µg/L	71	180	PSL based on HERD Note 3 value of 30
bis(2-Ethylhexyl)Phthalate	117-81-7	µg/L	0.071	4.8	Current PSL based on MCL
Hexachlorocyclopentadiene	77-47-4	µg/L	22	220	Current PSL based on MCL
Atrazine	1912-24-9	µg/L	0.26	0.29	Current PSL based on MCL
Endrin	72-20-8	µg/L	1.7	11	Current PSL based on MCL
HCH (gamma) Lindane	58-89-9	µg/L	0.036	0.061	Current PSL based on MCL
Heptachlor	76-44-8	µg/L	0.0018	0.015	Current PSL based on MCL
Heptachlor Epoxide	1024-57-3	µg/L	0.0033	0.0074	Current PSL based on MCL
Methoxychlor	72-43-5	µg/L	27	180	Current PSL based on MCL
Toxaphene	8001-35-2	µg/L	0.013	0.061	Current PSL based on MCL
2,4,6-Trichlorophenol	88-06-2	µg/L	3.5	6.1	PSL based HERD Note 3 value of 0.96
New or Decreased PSL					
Chromium (hexavalent)	18540-29-9	µg/L	0.031	0.043	PSL based on 2010 RSL. Analyte not detected.
Cobalt	7440-48-4	µg/L	4.7	11	PSL based on 2010 RSL Analyte not detected above 2.1 µg/L in wells. Only 2 of 45 grab samples exceed 4.7 µg/L (4%), with a maximum of 15.5
Dibenzofuran	132-64-9	µg/L	5.8	37	PSL based on HERD Note 3 value of 12. Not detected.
Molybdenum	7439-98-7	µg/L	78	180	PSL based on 2010 RSL. Analyte not detected above 55 ug/L.
1,1,1,2-Tetrachloroethane	630-20-6	µg/L	0.50	0.52	PSL based on 2010 RSL. Analyte not detected
1,2,3-Trichlorobenzene	87-61-6	µg/L	5.2	29	PSL based on 2010 RSL. Analyte not detected
1,2,3-Trichloropropane	96-18-4	µg/L	0.00065	0.00072	PSL based on 2010 RSL. Analyte not detected
1,3,5-Trimethylbenzene	108-67-8	µg/L	87	370	PSL based on 2010 RSL. Analyte not detected

Compound	CAS No.	Units	USEPA 2011 RSL	USEPA 2010 RSL	Comment
1,3-Butadiene	106-99-0	µg/L	0.016	0.018	PSL based on 2010 RSL. Analyte not detected
1,3-Dichloropropane	142-28-9	µg/L	290	730	PSL based on 2010 RSL. Analyte not detected
2-Butanone	78-93-3	µg/L	4900	7100	PSL based on 2010 RSL. Analyte not detected above 1.4 ug/L
4-Chlorotoluene	106-43-4	µg/L	190	2600	PSL based on 2010 RSL. Analyte not detected
4-Methyl-2-Pentanone	108-10-1	µg/L	1000	2000	PSL based on 2010 RSL. Analyte not detected above 0.2 ug/L
Acetone	67-64-1	µg/L	12000	22000	PSL based on 2010 RSL. Analyte not detected above 180 ug/L
Bromobenzene	108-86-1	µg/L	54	88	PSL based on 2010 RSL. Analyte not detected.
Bromomethane	74-83-9	µg/L	7.0	8.7	PSL based in 2010 RSL. Analyte not detected
Carbon Disulfide	75-15-0	µg/L	720	1000	PSL based on 2010 RSL. Analyte not detected above 1.8 ug/L.
Dibromomethane	74-95-3	µg/L	7.9	8.2	PSL based in 2010 RSL. Analyte not detected
Dichlorodifluoromethane	75-71-8	µg/L	190	390	PSL based in 2010 RSL. Analyte not detected
Hexachlorobutadiene	87-68-3	µg/L	0.26	0.86	PSL based in 2010 RSL. Analyte not detected
Isopropylbenzene	98-82-8	µg/L	390	680	PSL based in 2010 RSL. Analyte not detected.
Methyl n-Butyl Ketone	591-78-6	µg/L	34	47	PSL based in 2010 RSL. Analyte not detected
Anthracene	120-12-7	µg/L	1300	11000	PSL based on 2010 RSL. Analyte not detected above 0.05 ug/L.
Fluoranthene	206-44-0	µg/L	630	1500	PSL based in 2010 RSL. Analyte not detected above 3.9 ug/L

Compound	CAS No.	Units	USEPA 2011 RSL	USEPA 2010 RSL	Comment
Fluorene	86-73-7	µg/L	220	240	PSL based on 2010 RSL. Analyte not detected above 2.1 ug/L
Pyrene	129-00-0	µg/L	87	180	PSL based on 2010 RSL. Analyte not detected above 3.6 ug/L
2,4-Dichlorophenol	120-83-2	µg/L	35	110	PSL based on 2010 RSL. Analyte not detected.
2,4-Dimethylphenol	105-67-9	µg/L	270	730	PSL based on 2010 RSL. Analyte not detected.
2,4-Dinitrophenol	51-28-5	µg/L	30	73	PSL based on 2010 RSL. Analyte not detected.
2,4-Dinitrotoluene	121-14-2	µg/L	0.20	0.22	PSL based on 2010 RSL. Analyte not detected.
2,6-Dinitrotoluene	606-20-2	µg/L	15	37	PSL based on 2010 RSL. Analyte not detected.
2-Methylnaphthalene	91-57-6	µg/L	27	150	PSL based on 2010 RSL. Analyte not detected above 0.2 ug/L.
2-Methylphenol	95-48-7	µg/L	720	1800	PSL based on 2010 RSL Analyte not detected.
2-Nitroaniline	88-74-4	µg/L	150	370	PSL based on 2010 RSL. Analyte not detected.
3,3'-Dichlorobenzidine	91-94-1	µg/L	0.11	0.15	PSL based on 2010 RSL. Analyte not detected.
4,6-Dinitro-2-Methylphenol	534-52-1	µg/L	1.2	2.9	PSL based on 2010 RSL. Analyte not detected.
4-Chloro-3-Methylphenol	59-50-7	µg/L	1100	3700	PSL based on 2010 RSL. Analyte not detected.
4-Chloroaniline	106-47-8	µg/L	0.32	0.34	PSL based on 2010 RSL. Analyte not detected.
4-Methylphenol	106-44-5	µg/L	72	180	PSL based on 2010 RSL. Analyte not detected above 11 ug/L.
4-Nitroaniline	100-01-6	µg/L	3.3	3.4	PSL based on 2010 RSL Analyte not detected.
Azobenzene	103-33-3	µg/L	0.10	0.12	PSL based on 2010 RSL Analyte not detected.

Compound	CAS No.	Units	USEPA 2011 RSL	USEPA 2010 RSL	Comment
Benzoic acid	65-85-0	µg/L	58000	150000	PSL based on 2010 RSL. Analyte not detected above 32 ug/L.
Benzyl Alcohol	100-51-6	µg/L	1500	3700	PSL based on 2010 RSL. Analyte not detected above 1.5 ug/L.
bis(2-Chloroethoxy)Methane	111-91-1	µg/L	47	110	PSL based on 2010 RSL Analyte not detected.
Butyl Benzyl Phthalate	85-68-7	µg/L	14	35	PSL based on 2010 RSL. Analyte not detected.
Diethylphthalate	84-66-2	µg/L	11000	29000	PSL based on 2010 RSL. Analyte not detected.
Di-n-butylphthalate	84-74-2	µg/L	670	3700	PSL based on 2010 RSL. Analyte not detected.
Hexachloroethane	67-72-1	µg/L	0.79	4.8	PSL based on 2010 RSL. Analyte not detected.
Isophorone	78-59-1	µg/L	67	71	PSL based on 2010 RSL. Analyte not detected.
N-Nitroso-di-n-propylamine	621-64-7	µg/L	0.0093	0.0096	PSL based on 2010 RSL. Analyte not detected.
N-Nitrosodiphenylamine	86-30-6	µg/L	10	14	PSL based on 2010 RSL. Analyte not detected.
Phenol	108-95-2	µg/L	4500	11000	PSL based on 2010 RSL. Analyte not detected above 6.2 ug/L.
Arochlor-1221	11104-28-2	µg/L	0.0043	0.0068	PSL based on 2010 RSL. Analyte not detected.
Arochlor-1232	11141-16-5	µg/L	0.0043	0.0068	PSL based on 2010 RSL. Analyte not detected.
Aldrin	309-00-2	µg/L	0.00021	0.004	PSL based on 2010 RSL. Analyte not detected.
Alpha-BHC	319-84-6	µg/L	0.006	0.011	PSL based on 2010 RSL. Analyte not detected.
Beta-BHC	319-85-7	µg/L	0.022	0.037	PSL based on 2010 RSL. Analyte not detected.
Dieldrin	60-57-1	µg/L	0.0015	0.0042	PSL based on 2010 RSL. Analyte not detected.
Propiconazole	60207-90-1	µg/L	160	470	PSL based on 2010 RSL. Analyte not detected.

Compound	CAS No.	Units	USEPA 2011 RSL	USEPA 2010 RSL	Comment
2,3,4,6-Tetrachlorophenol	58-90-2	µg/L	170	1100	PSL based on 2010 RSL. Analyte not detected.
2,4,5-Trichlorophenol	95-95-4	µg/L	890	3700	PSL based on 2010 RSL. Analyte not detected.

Evaluation of Surface Water Screening Levels

Pond surface water data were compared to USEPA National Recommended Ambient Water Quality Criteria (NRAWQC) for freshwater aquatic life protection (as presented in Buchman, 2008) when available. Data were also screened against values presented in the California Toxics Rule (40 CFR Part 131) and *the Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota* (Suter and Tsao, 1996). A summary of the screening values considered for surface water evaluation is presented in Table D-6.

By request of NCRWQCB, pond surface water data were also compared to WQOs for Inland Surface Water provided by NCRWCB (DTSC, 2011). A summary of the Inland Surface Water WQOs is presented in Table D-7.

Evaluation of TPH Screening Levels

No CHHSLs, RSLs, or ecological benchmarks are available for TPH. Therefore, TPH data in soil and sediments were screened against site-specific screening levels for potential exposure via direct contact, indoor air, and leaching to groundwater. The development of the RBSCs, values protective of human health exposures, is described in detail in Appendix C of the RAWP (ARCADIS BBL, 2008b). RBSCs are specific to carbon chain ranges and were derived using some limited site-specific data. There are three ranges for total petroleum hydrocarbons as gasoline (TPHg), four ranges for total petroleum hydrocarbons as diesel (TPHd), and one range for total petroleum hydrocarbons as motor oil (TPHmo). Both aliphatic and aromatic RBSCs were developed for each carbon chain range. These RBSCs and their respective carbon chain ranges are presented in Table D-8.

TPH data collected at the site prior to late 2005 were not reported by the carbon ranges for TPHg and TPHd that the RBSCs were calculated for. TPHg was reported as the C7-C12 range, and these data are compared to the RBSCs for the C8-C10 range.

TPHd was reported as the C10-C24 range, and these data are compared to the RBSCs for the C16-C24 range. Although TPH data were screened against both the aliphatic and aromatic RBSCs in Appendix E of the Remedial Investigation (RI) Report for OU-E, the discussion in the text focuses on the comparison with the aliphatic RBSC. This is because sufficient data exist for aromatic constituents (benzene, toluene, ethylbenzene, and total xylenes [BTEX]) and PAHs in those areas where aromatic TPH fractions (TPHg and TPHd) are of potential concern. Therefore, any elevated concentrations of these constituents will be addressed in the screening of these constituents.

Although RBSCs were developed for the leaching to groundwater pathway, the values were derived through a model and not utilizing site-specific data. More recently, site-specific leachability data were used to calculate site-specific screening levels for the leaching to groundwater pathway (ARCADIS, 2010c), specifically for the TPHd fraction (TPHmo showed no significant leaching, and there is very little TPHg onsite). Therefore, for TPHd, both the human health fraction-specific RBSCs and the total TPHd screening level for the leaching to groundwater pathway are used in the RI Report for OU-E to evaluate TPH results.

MCLs, PHGs, and RSLs are not established for TPH. Therefore, in accordance with a DTSC comment on the revision to the Remedial Investigation Report, Operable Unit A (ARCADIS BBL, 2008b), TPH data are screened against the site-specific RBSCs developed by ARCADIS BBL (2008b) for groundwater. As for soil, only exceedances of aliphatic RBSCs are discussed in the text. In accordance with a request from NCRWQCB (2008), TPH data are also compared to their taste- and odor-based objectives (CVRWQCB, 2004), which is consistent with the RWQCB WQO approach above.

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Tables

Appendix D - Selection of Screening Level Values for Data Evaluation

Table D-1
Soil and Sediment Human Health Screening Levels

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Soil and Sediment Screening Levels (residential)						Primary Soil /Sediment Screening Level[ac]	
			Background [a]							
			Fill	Marine Sediment/ Bedrock	USEPA RSL[ab]	CalEPA CHHSL [b]	CA DTSC HERD [c] Note 3	CDRG (Dioxins / Furans Only) [d]	Value	Source
Metals										
Antimony	7440-36-0	mg/kg	0.97	0.97	31 [e]	30 [e]	--	--	30	CalEPA CHHSLr
Arsenic	7440-38-2	mg/kg	10	10	0.39	0.07	0.062	--	10 / 0.07	Background /CHHSL
Barium	7440-39-3	mg/kg	310	100	15,000	5,200 [g]	--	--	5,200	CalEPA CHHSLr
Beryllium	7440-41-7	mg/kg	1.1	1.1	160	16 [h]	--	--	16	CalEPA CHHSLr
Cadmium	7440-43-9	mg/kg	2.8	2.8	70	39 [i,j]	1.7	--	39	CalEPA CHHSLr
Chromium	7440-47-3	mg/kg	60	42	120,000 [l]	100,000 [l]	--	--	100,000	CalEPA CHHSLr
Chromium (VI)	18540-29-9	mg/kg	--	--	0.29	17	17	--	17	CalEPA CHHSLr
Cobalt	7440-48-4	mg/kg	20	20	23	660	--	--	660	CalEPA CHHSLr
Copper	7440-50-8	mg/kg	53	36	3,100 [m]	3,000 [m]	--	--	3,000	CalEPA CHHSLr
Lead	7439-92-1	mg/kg	25	22	400 [n]	80 [n]	150	--	80	CalEPA CHHSLr
Mercury	7439-97-6	mg/kg	0.12	0.12	23 [p]	18 [o]	--	--	18	CalEPA CHHSLr
Molybdenum	7439-98-7	mg/kg	4.6	0.7	390	380	--	--	380	CalEPA CHHSLr
Nickel	7440-02-0	mg/kg	41	41	1,500 [r]	1,600 [q]	--	--	1,600	CalEPA CHHSLr
Selenium	7782-49-2	mg/kg	0.82	0.82	390	380	--	--	380	CalEPA CHHSLr
Silver	7440-22-4	mg/kg	0.22	0.22	390	380 [s]	--	--	380	CalEPA CHHSLr
Thallium	7440-28-0	mg/kg	0.67	0.67	--	5 [t]	--	--	5	CalEPA CHHSLr
Vanadium	7440-62-2	mg/kg	90	90	390 [u]	530 [u]	78	--	530	CalEPA CHHSLr
Zinc	7440-66-6	mg/kg	160	84	23,000	23,000	--	--	23,000	CalEPA CHHSLr
Volatile Organic Compounds (VOCs)										
1,1,1,2-Tetrachloroethane	630-20-6	mg/kg	--	--	1.9	--	--	--	1.9	USEPA RSLr
1,1,1-Trichloroethane	71-55-6	mg/kg	--	--	8,700	--	--	--	8,700	USEPA RSLr
1,1,2,2-Tetrachloroethane	79-34-5	mg/kg	--	--	0.56	--	--	--	0.56	USEPA RSLr
1,1,2-Trichloroethane	79-00-5	mg/kg	--	--	1.1	--	--	--	1.1	USEPA RSLr
1,1-Dichloroethane	75-34-3	mg/kg	--	--	3.3	--	--	--	3.3	USEPA RSLr
1,1-Dichloroethene	75-35-4	mg/kg	--	--	240	--	--	--	240	USEPA RSLr
1,1-Dichloropropene	563-58-6	mg/kg	--	--	--	--	--	--	--	--
1,2,3-Trichlorobenzene	87-61-6	mg/kg	--	--	49	--	--	--	49	USEPA RSLr
1,2,3-Trichloropropane	96-18-4	mg/kg	--	--	0.005	--	--	--	0.005	USEPA RSLr
1,2,4-Trichlorobenzene	120-82-1	mg/kg	--	--	22	--	--	--	22	USEPA RSLr
1,2,4-Trimethylbenzene	95-63-6	mg/kg	--	--	62	--	--	--	62	USEPA RSLr
1,2-Dibromo-3-Chloropropane	96-12-8	mg/kg	--	--	0.0054	--	--	--	0.0054	USEPA RSLr
1,2-Dibromoethane	106-93-4	mg/kg	--	--	0.034	--	--	--	0.034	USEPA RSLr
1,2-Dichlorobenzene	95-50-1	mg/kg	--	--	1,900	--	--	--	1,900	USEPA RSLr
1,2-Dichloroethane	107-06-2	mg/kg	--	--	0.43	--	--	--	0.43	USEPA RSLr
1,2-Dichloropropane	78-87-5	mg/kg	--	--	0.89	--	--	--	0.89	USEPA RSLr

Table D-1
Soil and Sediment Human Health Screening Levels

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Soil and Sediment Screening Levels (residential)						Primary Soil /Sediment Screening Level[ac]	
			Background [a]		USEPA RSL[ab]	CalEPA CHHSL [b]	CA DTSC HERD [c] Note 3	CDRG (Dioxins / Furans Only) [d]	Value	Source
			Fill	Marine Sediment/ Bedrock						
1,3,5-Trimethylbenzene	108-67-8	mg/kg	--	--	780	--	--	--	780	USEPA RSLr
1,3-Dichlorobenzene	541-73-1	mg/kg	--	--	--	--	530	--	530	DTSC HERD Note 3
1,3-Dichloropropane	142-28-9	mg/kg	--	--	1,600	--	--	--	1,600	USEPA RSLr
1,4-Dichlorobenzene	106-46-7	mg/kg	--	--	2.4	--	--	--	2.4	USEPA RSLr
2,2-Dichloropropane	594-20-7	mg/kg	--	--	--	--	--	--	--	--
2-Butanone	78-93-3	mg/kg	--	--	28,000	--	--	--	28,000	USEPA RSLr
2-Chlorotoluene	95-49-8	mg/kg	--	--	1,600	--	160	--	160	DTSC HERD Note 3
4-Chlorotoluene	106-43-4	mg/kg	--	--	5,500	--	--	--	5,500	USEPA RSLr
4-Methyl-2-Pentanone	108-10-1	mg/kg	--	--	5,300	--	--	--	5,300	USEPA RSLr
Acetone	67-64-1	mg/kg	--	--	61,000	--	--	--	61,000	USEPA RSLr
Benzene	71-43-2	mg/kg	--	--	1.1	--	--	--	1.1	USEPA RSLr
Bromobenzene	108-86-1	mg/kg	--	--	300	--	--	--	300	USEPA RSLr
Bromochloromethane	74-97-5	mg/kg	--	--	--	--	--	--	--	--
Bromodichloromethane	75-27-4	mg/kg	--	--	0.27	--	--	--	0.27	USEPA RSLr
Bromoform	75-25-2	mg/kg	--	--	61	--	--	--	61	USEPA RSLr
Bromomethane	74-83-9	mg/kg	--	--	7.3	--	--	--	7.3	USEPA RSLr
Carbon Disulfide	75-15-0	mg/kg	--	--	820	--	--	--	820	USEPA RSLr
Carbon Tetrachloride	56-23-5	mg/kg	--	--	0.61	--	--	--	0.61	USEPA RSLr
Chlorinated Fluorocarbon (Freon 113)	76-13-1	mg/kg	--	--	43,000	--	--	--	43,000	USEPA RSLr
Chlorobenzene	108-90-7	mg/kg	--	--	290	--	--	--	290	USEPA RSLr
Chloroethane	75-00-3	mg/kg	--	--	15,000	--	3	--	3	DTSC HERD Note 3
Chloroform	67-66-3	mg/kg	--	--	0.29	--	--	--	0.29	USEPA RSLr
Chloromethane	74-87-3	mg/kg	--	--	120	--	--	--	120	USEPA RSLr
cis-1,2-Dichloroethene	156-59-2	mg/kg	--	--	160	--	--	--	160	USEPA RSLr
cis-1,3-Dichloropropene	10061-01-5	mg/kg	--	--	1.7	--	--	--	1.7	USEPA RSLr
Dibromochloromethane	124-48-1	mg/kg	--	--	0.68	--	--	--	0.68	USEPA RSLr
Dibromomethane	74-95-3	mg/kg	--	--	25	--	67	--	25	USEPA RSLr
Dichlorodifluoromethane	75-71-8	mg/kg	--	--	180	--	--	--	180	USEPA RSLr
Ethanol	64-17-5	mg/kg	--	--	--	--	--	--	--	--
Ethylbenzene	100-41-4	mg/kg	--	--	5.4	--	--	--	5.4	USEPA RSLr
Hexachlorobutadiene	87-68-3	mg/kg	--	--	6.2	--	--	--	6.2	USEPA RSLr
Isopropyl Alcohol	67-63-0	mg/kg	--	--	9.90E+09	--	--	--	9.90E+09	USEPA RSLr
Isopropylbenzene	98-82-8	mg/kg	--	--	2,100	--	--	--	2,100	USEPA RSLr
Methyl n-Butyl Ketone	591-78-6	mg/kg	--	--	210	--	--	--	210	USEPA RSLr
Methylene Chloride	75-09-2	mg/kg	--	--	11	--	--	--	11	USEPA RSLr
MTBE	1634-04-4	mg/kg	--	--	43	--	--	--	43	USEPA RSLr
Naphthalene	91-20-3	mg/kg	--	--	3.6	--	--	--	3.6	USEPA RSLr
n-Butylbenzene	104-51-8	mg/kg	--	--	-- [w]	--	240	--	240	DTSC HERD Note 3
n-Propylbenzene	103-65-1	mg/kg	--	--	3,400 [w]	--	240	--	240	DTSC HERD Note 3

Table D-1
Soil and Sediment Human Health Screening Levels

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Soil and Sediment Screening Levels (residential)						Primary Soil /Sediment Screening Level[ac]	
			Background [a]							
			Fill	Marine Sediment/ Bedrock	USEPA RSL[ab]	CalEPA CHHSL [b]	CA DTSC HERD [c] Note 3	CDRG (Dioxins / Furans Only) [d]	Value	Source
p-Isopropyl Toluene	99-87-6	mg/kg	--	--	--	--	--	--	--	--
sec-Butylbenzene	135-98-8	mg/kg	--	--	-- w	--	220	--	220	DTSC HERD Note 3
Styrene	100-42-5	mg/kg	--	--	6,300	--	--	--	6,300	USEPA RSLr
Tert-Butylbenzene	98-06-6	mg/kg	--	--	-- w	--	390	--	390	DTSC HERD Note 3
Tetrachloroethene	127-18-4	mg/kg	--	--	0.55	--	--	--	0.55	USEPA RSLr
Toluene	108-88-3	mg/kg	--	--	5,000	--	--	--	5,000	USEPA RSLr
trans-1,2-Dichloroethene	156-60-5	mg/kg	--	--	150	--	--	--	150	USEPA RSLr
trans-1,3-Dichloropropene	10061-02-6	mg/kg	--	--	1.7	--	--	--	1.7	USEPA RSLr
Trichloroethene	79-01-6	mg/kg	--	--	2.8	--	--	--	2.8	USEPA RSLr
Trichlorofluoromethane	75-69-4	mg/kg	--	--	790	--	--	--	790	USEPA RSLr
Vinyl Acetate	108-05-4	mg/kg	--	--	970	--	--	--	970	USEPA RSLr
Vinyl Chloride	75-01-4	mg/kg	--	--	0.06	--	--	--	0.06	USEPA RSLr
Xylenes, m,p-	1330-20-7	mg/kg	--	--	630	--	--	--	630	USEPA RSLr
Xylenes, o-	95-47-6	mg/kg	--	--	3,800	--	--	--	3,800	USEPA RSLr
Xylenes, Total	1330-20-7	mg/kg	--	--	630	--	--	--	630	USEPA RSLr
Semivolatile Organic Compounds (SVOCs)										
1,2,4-Trichlorobenzene	120-82-1	mg/kg	--	--	22	--	--	--	22	USEPA RSLr
1,2-Dichlorobenzene	95-50-1	mg/kg	--	--	1,900	--	--	--	1900	USEPA RSLr
1,3-Dichlorobenzene	541-73-1	mg/kg	--	--	--	--	530	--	530	DTSC HERD Note 3
1,4-Dichlorobenzene	106-46-7	mg/kg	--	--	2.4	--	--	--	2.4	USEPA RSLr
2,3,4,6-Tetrachlorophenol	58-90-2	mg/kg	--	--	1,800	--	--	--	1800	USEPA RSLr
2,4,5-Trichlorophenol	95-95-4	mg/kg	--	--	6,100	--	--	--	6100	USEPA RSLr
2,4,6-Trichlorophenol	88-06-2	mg/kg	--	--	44	--	6.9	--	6.9	DTSC HERD Note 3
2,4-Dichlorophenol	120-83-2	mg/kg	--	--	180	--	--	--	180	USEPA RSLr
2,4-Dimethylphenol	105-67-9	mg/kg	--	--	1,200	--	--	--	1200	USEPA RSLr
2,4-Dinitrophenol	51-28-5	mg/kg	--	--	120	--	--	--	120	USEPA RSLr
2,4-Dinitrotoluene	121-14-2	mg/kg	--	--	1.6	--	--	--	1.6	USEPA RSLr
2,6-Dinitrotoluene	606-20-2	mg/kg	--	--	61	--	--	--	61	USEPA RSLr
2-Chloronaphthalene	91-58-7	mg/kg	--	--	6,300	--	--	--	6,300	USEPA RSLr
2-Chlorophenol	95-57-8	mg/kg	--	--	390	--	63	--	63	DTSC HERD Note 3
2-Methylnaphthalene	91-57-6	mg/kg	--	--	310	--	--	--	310	USEPA RSLr
2-Methylphenol	95-48-7	mg/kg	--	--	3,100	--	--	--	3,100	USEPA RSLr
2-Nitroaniline	88-74-4	mg/kg	--	--	610	--	--	--	610	USEPA RSLr
2-Nitrophenol	88-75-5	mg/kg	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	91-94-1	mg/kg	--	--	1.1	--	--	--	1.1	USEPA RSLr
3-Nitroaniline	99-09-2	mg/kg	--	--	--	--	18	--	18	DTSC HERD Note 3
4,6-Dinitro-2-Methylphenol	534-52-1	mg/kg	--	--	4.9	--	--	--	4.9	USEPA RSLr
4-Bromophenyl-phenylether	101-55-3	mg/kg	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	59-50-7	mg/kg	--	--	6,100	--	--	--	6,100	USEPA RSLr
4-Chloroaniline	106-47-8	mg/kg	--	--	2.4	--	--	--	2.4	USEPA RSLr
4-Chlorophenyl-phenylether	7005-72-3	mg/kg	--	--	--	--	--	--	--	--
4-Methylphenol	106-44-5	mg/kg	--	--	310	--	--	--	310	USEPA RSLr

Table D-1
Soil and Sediment Human Health Screening Levels

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Constituent/Analytical Group	CAS No.	Units	Soil and Sediment Screening Levels (residential): Background [a] Fill	Background [a] Marine Sediment/ Bedrock	USEPA RSL[ab]	CalEPA CHHSL [b]	CA DTSC HERD [c] Note 3	CDRG (Dioxins / Furans Only) [d]	Primary Soil /Sediment Screening Level[ac]: Value	Source
4-Nitroaniline	100-01-6	mg/kg	--	--	24	--	--	--	24	USEPA RSLr
4-Nitrophenol	100-02-7	mg/kg	--	--	--	--	--	--	--	--
Acenaphthene	83-32-9	mg/kg	--	--	3,400	--	--	--	3,400	USEPA RSLr
Acenaphthylene	208-96-8	mg/kg	--	--	--	--	--	--	--	--
Anthracene	120-12-7	mg/kg	--	--	17,000	--	--	--	17,000	USEPA RSLr
Azobenzene	103-33-3	mg/kg	--	--	5.1	--	--	--	5.1	USEPA RSLr
Benzo(a)anthracene	56-55-3	mg/kg	--	--	0.15	--	--	--	0.15	USEPA RSLr
Benzo(a)pyrene	50-32-8	mg/kg	--	--	0.015	0.038	--	--	0.038	CalEPA CHHSLr
Benzo(b)fluoranthene	205-99-2	mg/kg	--	--	0.15	--	--	--	0.15	USEPA RSLr
Benzo(g,h,i)perylene	191-24-2	mg/kg	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	207-08-9	mg/kg	--	--	1.5	--	0.38	--	0.38	DTSC HERD Note 3
Benzoic acid	65-85-0	mg/kg	--	--	240,000	--	--	--	240,000	USEPA RSLr
Benzyl Alcohol	100-51-6	mg/kg	--	--	6,100	--	--	--	6,100	USEPA RSLr
bis(2-Chloroethoxy)Methane	111-91-1	mg/kg	--	--	180	--	--	--	180	USEPA RSLr
bis(2-Chloroethyl)Ether	111-44-4	mg/kg	--	--	0.21	--	--	--	0.21	USEPA RSLr
bis(2-Chloroisopropyl)ether	39638-32-9	mg/kg	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)Phthalate	117-81-7	mg/kg	--	--	35	--	--	--	35	USEPA RSLr
Butyl Benzyl Phthalate	85-68-7	mg/kg	--	--	260	--	--	--	260	USEPA RSLr
Chrysene	218-01-9	mg/kg	--	--	15	--	3.8	--	3.8	DTSC HERD Note 3
Dibenz(a,h)anthracene	53-70-3	mg/kg	--	--	0.015	--	--	--	0.015	USEPA RSLr
Dibenzofuran	132-64-9	mg/kg	--	--	78	--	150	--	78	USEPA RSLr
Diethylphthalate	84-66-2	mg/kg	--	--	49,000	--	--	--	49,000	USEPA RSLr
Dimethylphthalate	131-11-3	mg/kg	--	--	--	--	100,000	--	100,000	DTSC HERD Note 3
Di-n-butylphthalate	84-74-2	mg/kg	--	--	6,100	--	--	--	6,100	USEPA RSLr
Di-n-octylphthalate	117-84-0	mg/kg	--	--	--	--	2,400	--	2,400	DTSC HERD Note 3
Fluoranthene	206-44-0	mg/kg	--	--	2,300	--	--	--	2,300	USEPA RSLr
Fluorene	86-73-7	mg/kg	--	--	2,300	--	--	--	2,300	USEPA RSLr
Hexachlorobenzene	118-74-1	mg/kg	--	--	0.3	--	--	--	0.3	USEPA RSLr
Hexachlorobutadiene	87-68-3	mg/kg	--	--	6.2	--	--	--	6.2	USEPA RSLr
Hexachlorocyclopentadiene	77-47-4	mg/kg	--	--	370	--	--	--	370	USEPA RSLr
Hexachloroethane	67-72-1	mg/kg	--	--	35	--	--	--	35	USEPA RSLr
Indeno(1,2,3-cd)Pyrene	193-39-5	mg/kg	--	--	0.15	--	--	--	0.15	USEPA RSLr
Isophorone	78-59-1	mg/kg	--	--	510	--	--	--	510	USEPA RSLr
Naphthalene	91-20-3	mg/kg	--	--	3.6	--	--	--	3.6	USEPA RSLr
Nitrobenzene	98-95-3	mg/kg	--	--	4.8	--	--	--	4.8	USEPA RSLr
n-Nitrosodimethylamine	62-75-9	mg/kg	--	--	0.0023	--	--	--	0.0023	USEPA RSLr
n-Nitroso-di-n-propylamine	621-64-7	mg/kg	--	--	0.069	--	--	--	0.069	USEPA RSLr
n-Nitrosodiphenylamine	86-30-6	mg/kg	--	--	99	--	--	--	99	USEPA RSLr
Pentachlorophenol	87-86-5	mg/kg	--	--	0.89	4.4	--	--	4.4	CalEPA CHHSLr
Phenanthrene	85-01-8	mg/kg	--	--	--	--	--	--	--	--
Phenol	108-95-2	mg/kg	--	--	18,000	--	--	--	18,000	USEPA RSLr
Pyrene	129-00-0	mg/kg	--	--	1,700	--	--	--	1,700	USEPA RSLr

Table D-1
Soil and Sediment Human Health Screening Levels

Draft Remedial Investigation Report Operable Unit E
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			Soil and Sediment Screening Levels (residential)						Primary Soil /Sediment Screening Level[ac]	
			Background [a]							
Constituent/Analytical Group	CAS No.	Units	Fill	Marine Sediment/ Bedrock	USEPA RSL[ab]	CalEPA CHHSL [b]	CA DTSC HERD [c] Note 3	CDRG (Dioxins / Furans Only) [d]	Value	Source
Resorcinol	108-46-3	mg/kg	--	--	--	--	--	--	--	--
Total PAH	NA	mg/kg	--	--	--	--	--	--	--	--
USEPA B(a)P TEQ	NA	mg/kg	--	--	0.015	0.038	--	--	0.038	CalEPA CHHSLr
Polycyclic Aromatic Hydrocarbons (PAHs)										
2-Methylnaphthalene	91-57-6	mg/kg	--	--	310	--	--	--	310	USEPA RSLr
Acenaphthene	83-32-9	mg/kg	--	--	3,400	--	--	--	3,400	USEPA RSLr
Acenaphthylene	208-96-8	mg/kg	--	--	--	--	--	--	--	--
Anthracene	120-12-7	mg/kg	--	--	17,000	--	--	--	17,000	USEPA RSLr
Benzo(a)anthracene	56-55-3	mg/kg	--	--	0.15	--	--	--	0.15	USEPA RSLr
Benzo(a)pyrene	50-32-8	mg/kg	--	--	0.015	0.038	--	--	0.038	CalEPA CHHSLr
Benzo(b)fluoranthene	205-99-2	mg/kg	--	--	0.15	--	--	--	0.15	USEPA RSLr
Benzo(g,h,i)perylene	191-24-2	mg/kg	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	207-08-9	mg/kg	--	--	1.5	--	0.38	--	0.38	DTSC HERD Note 3
Chrysene	218-01-9	mg/kg	--	--	15	--	3.8	--	3.8	DTSC HERD Note 3
Dibenz(a,h)anthracene	53-70-3	mg/kg	--	--	0.015	--	--	--	0.015	USEPA RSLr
Fluoranthene	206-44-0	mg/kg	--	--	2,300	--	--	--	2,300	USEPA RSLr
Fluorene	86-73-7	mg/kg	--	--	2,300	--	--	--	2,300	USEPA RSLr
Indeno(1,2,3-cd)Pyrene	193-39-5	mg/kg	--	--	0.15	--	--	--	0.15	USEPA RSLr
Naphthalene	91-20-3	mg/kg	--	--	3.6	--	--	--	3.6	USEPA RSLr
Phenanthrene	85-01-8	mg/kg	--	--	--	--	--	--	--	--
Pyrene	129-00-0	mg/kg	--	--	1,700	--	--	--	1,700	USEPA RSLr
LMW PAH	NA	mg/kg	--	--	--	--	--	--	--	--
HMW PAH	NA	mg/kg	--	--	--	--	--	--	--	--
Total PAH	NA	mg/kg	--	--	--	--	--	--	--	--
USEPA B(a)P TEQ	NA	mg/kg	--	--	0.015	0.038	--	--	0.038	CalEPA CHHSLr
Organochlorine Pesticides										
4,4'-DDD	72-54-8	mg/kg	--	--	2 x	2.3 x	--	--	2.3	CalEPA CHHSLr
4,4'-DDE	72-55-9	mg/kg	--	--	1.4 y	1.6 y	--	--	1.6	CalEPA CHHSLr
4,4'-DDT	50-29-3	mg/kg	--	--	1.7 x	1.6 x	--	--	1.6	CalEPA CHHSLr
Aldrin	309-00-2	mg/kg	--	--	0.029	0.033	--	--	0.033	CalEPA CHHSLr
Alpha-BHC	319-84-6	mg/kg	--	--	0.077	--	--	--	0.077	USEPA RSLr
Alpha-Chlordane	5103-71-9	mg/kg	--	--	1.6 z	0.43 z	--	--	0.43	CalEPA CHHSLr
Atrazine	1912-24-9	mg/kg	--	--	2.1	--	--	--	2.1	USEPA RSLr
Beta-BHC	319-85-7	mg/kg	--	--	0.27	--	--	--	0.27	USEPA RSLr
Delta-BHC	319-86-8	mg/kg	--	--	--	--	--	--	--	--
Dieldrin	60-57-1	mg/kg	--	--	0.03	0.035	--	--	0.035	CalEPA CHHSLr
Endosulfan I	959-98-8	mg/kg	--	--	--	--	--	--	--	--
Endosulfan II	33213-65-9	mg/kg	--	--	--	--	--	--	--	--
Endosulfan Sulfate	1031-07-8	mg/kg	--	--	--	--	--	--	--	--
Endrin	72-20-8	mg/kg	--	--	18	21	--	--	21	CalEPA CHHSLr
Endrin Aldehyde	7421-93-4	mg/kg	--	--	--	--	--	--	--	--
Endrin Ketone	53494-70-5	mg/kg	--	--	--	--	--	--	--	--

Table D-1
Soil and Sediment Human Health Screening Levels

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Constituent/Analytical Group	CAS No.	Units	Soil and Sediment Screening Levels (residential)						Primary Soil /Sediment Screening Level[ac]	
			Background [a]							
			Fill	Marine Sediment/ Bedrock	USEPA RSL[ab]	CalEPA CHHSL [b]	CA DTSC HERD [c] Note 3	CDRG (Dioxins / Furans Only) [d]	Value	Source
Gamma-Chlordane	5103-74-2	mg/kg	--	--	1.6 z	0.43 z	--	--	0.43	CalEPA CHHSLr
Heptachlor	76-44-8	mg/kg	--	--	0.11	0.13	--	--	0.13	CalEPA CHHSLr
Heptachlor Epoxide	1024-57-3	mg/kg	--	--	0.053	--	--	--	0.053	USEPA RSLr
HCH (gamma) Lindane	58-89-9	mg/kg	--	--	0.52	0.5	--	--	0.5	CalEPA CHHSLr
Methoxychlor	72-43-5	mg/kg	--	--	310	340	--	--	340	CalEPA CHHSLr
Propiconazole	60207-90-1	mg/kg	--	--	790	--	--	--	790	USEPA RSLr
Toxaphene	8001-35-2	mg/kg	--	--	0.44	0.46	--	--	0.46	CalEPA CHHSLr
Triphenyl phosphate	115-86-6	mg/kg	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)										
Aroclor-1016	12674-11-2	mg/kg	--	--	3.9	--	--	--	3.9	USEPA RSLr
Aroclor-1221	11104-28-2	mg/kg	--	--	0.14	--	--	--	0.14	USEPA RSLr
Aroclor-1232	11141-16-5	mg/kg	--	--	0.14	--	--	--	0.14	USEPA RSLr
Aroclor-1242	53469-21-9	mg/kg	--	--	0.22	--	--	--	0.22	USEPA RSLr
Aroclor-1248	12672-29-6	mg/kg	--	--	0.22	--	--	--	0.22	USEPA RSLr
Aroclor-1254	11097-69-1	mg/kg	--	--	0.22	--	--	--	0.22	USEPA RSLr
Aroclor-1260	11096-82-5	mg/kg	--	--	0.22	--	--	--	0.22	USEPA RSLr
Aroclor-1268	11100-14-4	mg/kg	--	--	--	--	--	--	--	--
PCB# 8	34883-43-7	mg/kg	--	--	--	--	--	--	--	--
PCB# 18	37680-65-2	mg/kg	--	--	--	--	--	--	--	--
PCB# 28	7012-37-5	mg/kg	--	--	--	--	--	--	--	--
PCB# 44	41464-39-5	mg/kg	--	--	--	--	--	--	--	--
PCB# 52	35693-99-3	mg/kg	--	--	--	--	--	--	--	--
PCB# 66	32598-10-0	mg/kg	--	--	--	--	--	--	--	--
PCB# 77	32598-13-3	mg/kg	--	--	0.034	--	--	--	0.034	USEPA RSLr
PCB# 81	70362-50-4	mg/kg	--	--	0.011	--	--	--	0.011	USEPA RSLr
PCB# 101	37680-73-2	mg/kg	--	--	--	--	--	--	--	--
PCB# 105	32598-14-4	mg/kg	--	--	0.11	--	--	--	0.11	USEPA RSLr
PCB# 114	74472-37-0	mg/kg	--	--	0.11	--	--	--	0.11	USEPA RSLr
PCB# 118	31508-00-6	mg/kg	--	--	0.11	--	--	--	0.11	USEPA RSLr
PCB# 123	65510-44-3	mg/kg	--	--	0.11	--	--	--	0.11	USEPA RSLr
PCB# 126	57465-28-8	mg/kg	--	--	0.000034	--	--	--	0.000034	USEPA RSLr
PCB# 128	38380-07-3	mg/kg	--	--	--	--	--	--	--	--
PCB# 138	35065-28-2	mg/kg	--	--	--	--	--	--	--	--
PCB# 153	35065-27-1	mg/kg	--	--	--	--	--	--	--	--
PCB# 156	38380-08-4	mg/kg	--	--	0.11	--	--	--	0.11	USEPA RSLr
PCB# 157	69782-90-7	mg/kg	--	--	0.11	--	--	--	0.11	USEPA RSLr
PCB# 167	52663-72-6	mg/kg	--	--	0.11	--	--	--	0.11	USEPA RSLr

Table D-1
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Constituent/Analytical Group	CAS No.	Units	Soil and Sediment Screening Levels (residential)						Primary Soil /Sediment Screening Level[ac]	
			Background [a]							
			Fill	Marine Sediment/ Bedrock	USEPA RSL[ab]	CalEPA CHHSL [b]	CA DTSC HERD [c] Note 3	CDRG (Dioxins / Furans Only) [d]	Value	Source
PCB# 169	32774-16-6	mg/kg	--	--	0.00011	--	--	--	0.00011	USEPA RSLr
PCB# 170	35065-30-6	mg/kg	--	--	--	--	--	--	--	--
PCB# 180	35065-29-3	mg/kg	--	--	--	--	--	--	--	--
PCB# 187	52663-68-0	mg/kg	--	--	--	--	--	--	--	--
PCB# 189	39635-31-9	mg/kg	--	--	0.11	--	--	--	0.11	USEPA RSLr
PCB# 195	52663-78-2	mg/kg	--	--	--	--	--	--	--	--
PCB# 206	40186-72-9	mg/kg	--	--	--	--	--	--	--	--
PCB# 209	2051-24-3	mg/kg	--	--	--	--	--	--	--	--
Total PCBs	NA	mg/kg	--	--	0.22	0.089 [aa]	--	--	0.22	USEPA RSLr
Dioxins and Furans										
2,3,7,8-TCDD TEQ	NA	pg/g	--	--	4.5	4.6	--	50	4.6	CalEPA CHHSLr
2,3,7,8-TCDD (Dioxin)	1746-01-6	pg/g	--	--	--	--	--	--	--	CalEPA CHHSLr
1,2,3,7,8-PeCDD	40321-76-4	pg/g	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HxCDD	39227-28-6	pg/g	--	--	94	--	--	--	94	USEPA RSLr
1,2,3,6,7,8-HxCDD	57653-85-7	pg/g	--	--	94	--	--	--	94	USEPA RSLr
1,2,3,7,8,9-HxCDD	19408-74-3	pg/g	--	--	94	--	--	--	94	USEPA RSLr
1,2,3,4,6,7,8-HpCDD	35822-46-9	pg/g	--	--	--	--	--	--	--	--
OCDD	3268-87-9	pg/g	--	--	--	--	--	--	--	--
2,3,7,8-TCDF	51207-31-9	pg/g	--	--	--	--	--	--	--	--
1,2,3,7,8-PeCDF	57117-41-6	pg/g	--	--	--	--	--	--	--	--
2,3,4,7,8-PeCDF	57117-31-4	pg/g	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HxCDF	70648-26-9	pg/g	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HxCDF	57117-44-9	pg/g	--	--	--	--	--	--	--	--
2,3,4,6,7,8-HxCDF	60851-34-5	pg/g	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HxCDF	72918-21-9	pg/g	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HpCDF	67562-39-4	pg/g	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-HpCDF	55673-89-7	pg/g	--	--	--	--	--	--	--	--
OCDF	39001-02-0	pg/g	--	--	--	--	--	--	--	--

Table D-1
Soil and Sediment Human Health Screening Levels

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Constituent/Analytical Group	CAS No.	Units	Soil and Sediment Screening Levels (residential)						Primary Soil /Sediment Screening Level[ac]	
			Background [a]		USEPA RSL[ab]	CalEPA CHHSL [b]	CA DTSC HERD [c] Note 3	CDRG (Dioxins / Furans Only) [d]	Value	Source
			Fill	Marine Sediment/ Bedrock						

Acronyms and Abbreviations:

-- = not available	not available
CalEPA	California Environmental Protection Agency
Cas. No.	Chemical Abstract Service number
CA DTSC HERD	California Department of Toxic Substances Control Human and Ecological Risk Division
CHHSL	California Human Health Screening Levels for Soil
CDRG	California Dioxin Remediation Goal
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyl trichloroethane
EcoSSL	Ecological Soil Screening Level
ESL	environmental screening level
HMW	high molecular weight
HxCDD	hexachlorodibenzo-p-dioxin
HxCDF	hexachlorodibenzofuran
LMW	low molecular weight
mg/kg	milligrams per kilogram
MTBE	methyl tertiary-butyl ether
NA	not applicable
OCDD	octachlorodibenzo-p-dioxin
OCDF	octachlorodibenzofuran
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PeCDD	pentachlorodibenzo-p-dioxin
PeCDF	pentachlorodibenzofuran
pg/g	picograms per gram
PRG	preliminary remediation goal
RSL	regional screening level
SVOC	semivolatile organic compound
TEQ	toxic equivalent
USEPA	United States Environmental Protection Agency
VOC	volitile organic compound

Table D-1
Soil and Sediment Human Health Screening Levels

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Constituent/Analytical Group	CAS No.	Units	Soil and Sediment Screening Levels (residential)						Primary Soil /Sediment Screening Level[ac]	
			Background [a]		USEPA RSL[ab]	CalEPA CHHSL [b]	CA DTSC HERD [c] Note 3	CDRG (Dioxins / Furans Only) [d]	Value	Source
			Fill	Marine Sediment/ Bedrock						

Notes:
TPH screening levels are presented in Table D-8.
a. Separate site background concentrations were established for metals where the data set for Fill and Marine Sediment/Bedrock lithologies were determined to be of different populations. Otherwise, one background concentration was established, using the combined data sets, but for ease of use, it is shown in both columns.
b. Human health screening criteria are California Human Health Screening Levels for Soil (CHHSL, [CalEPA, 2005]), residential land use, unless otherwise noted.
c. 2004 U.S. EPA Region 9 'Cal-modified' PRGs for soil (USEPA, 2004a). Recommended by HERD in Note 3 (DTSC, 2009a).
d. California Dioxin Remediation Goal for residential soils (DTSC, 2009b).
e. Screening value for Antimony and compounds
g. Screening value for Barium and compounds
h. Screening value for Beryllium and compounds
i. Screening value for Cadmium and compounds
j. Calculated based on cadmium as carcinogen only via the inhalation route using current toxicity assessment by the OEHHA (2003). The recalculated CHHSL is actually based on the noncancer endpoint.
l. Screening value for Chromium III, Insoluble Salts
m. Screening value for Copper and compounds
n. Screening value for Lead and compounds
o. Screening value for Mercury and compounds
p. Screening value for Mercuric Chloride (and other Mercury salts)
q. Screening value for Nickel and compounds
r. Screening value for Nickel Soluble Salts
s. Screening value for Silver and compounds
t. Screening value for Thallium and compounds
u. Screening value for Vanadium and compounds
w. Soil saturation equation used for PRG value, which accounts for the amount of chemical sorbed onto soil (DTSC, 2009a).
x. Screening value for dichlorodiphenyldichloroethane (DDD)
y. Screening value for dichlorodiphenyldichloroethylene (DDE)
z. Screening value for Chlordane
aa. Residential RSL for total PCBs used as primary screening level because it is calculated using updated oral cancer potency factor currently recommended by OEHHA
ab. Regional Screening Levels (RSLs) for residential soil dated November 2010, incorporating DTSC (2009a) recommendations in HHRA Note 3 regarding the use of RSLs and DTSC's recommendation to use the more conservative of the latest RSL update and HHRA Note 3 recommended values (DTSC , 2010)
ac. Site-specific soil background metal concentrations were not incorporated into the sediment PSL. Only literature-based screening values were considered.

References:

- California Environmental Protection Agency (CalEPA). 2005. Use of California Human Health Screening Levels (CHHSLs) in Evaluation of Contaminated Properties. California Environmental Protection Agency.
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Table D-2
Soil Ecological Screening Levels

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			Soil Screening Levels								Primary Soil Screening Level [n]	
Constituent/Analytical Group	Cas. No.	Units	Invertebrate Contact Toxicity Benchmarks [a]		Source	Plant Contact Toxicity Benchmarks [b]		Source	Avian EcoSSL[c]	Mammalian EcoSSL[c]	Value	Source
Metals												
Antimony	7440-36-0	mg/kg	78	c	USEPA EcoSSL for invertebrates (USEPA, 2008).	5		Efroymson et al., 1997b	--	0.27	0.97	Background (See Table D-1)
Arsenic	7440-38-2	mg/kg	60		Efroymson et al., 1997a	18	c	USEPA EcoSSL for plants (USEPA, 2008).	43	46	18	USEPA EcoSSL for plants (USEPA, 2008).
Barium	7440-39-3	mg/kg	330	c	USEPA EcoSSL for invertebrates (USEPA, 2008).	500		Efroymson et al., 1997b	--	2000	330	USEPA EcoSSL for invertebrates (USEPA, 2008).
Beryllium	7440-41-7	mg/kg	40	c	USEPA EcoSSL for invertebrates (USEPA, 2008).	10		Efroymson et al., 1997b	--	21	10	Efroymson et al., 1997b
Cadmium	7440-43-9	mg/kg	140	c	USEPA EcoSSL for invertebrates (USEPA, 2008).	32	c	USEPA EcoSSL for plants (USEPA, 2008).	0.77	0.36	2.8	Background (See Table D-1)
Chromium	7440-47-3	mg/kg	0.4	m	Efroymson et al., 1997a	1	m	Efroymson et al., 1997b	26	34	42	Background (See Table D-1)
Chromium (VI)	18540-29-9	mg/kg	--		--	--		--	--	130	130	USEPA EcoSSL for mammals (USEPA, 2008)
Cobalt	7440-48-4	mg/kg	--		--	13	c	USEPA EcoSSL for plants (USEPA, 2008).	120	230	20	Background (See Table D-1)
Copper	7440-50-8	mg/kg	80	c	USEPA EcoSSL for invertebrates (USEPA, 2008).	70	c	USEPA EcoSSL for plants (USEPA, 2008).	28	49	36	Background (See Table D-1)
Lead	7439-92-1	mg/kg	1700	c	USEPA EcoSSL for invertebrates (USEPA, 2008).	120	c	USEPA EcoSSL for plants (USEPA, 2008).	11	56	22	Background (See Table D-1)
Mercury	7439-97-6	mg/kg	0.1		Efroymson et al., 1997a	0.3		Efroymson et al., 1997b	--	--	0.12	Background (See Table D-1)
Molybdenum	7439-98-7	mg/kg	40	f	Beyer (1990)	2		Efroymson et al., 1997b	--	--	2	Efroymson et al., 1997b
Nickel	7440-02-0	mg/kg	280	c	USEPA EcoSSL for invertebrates (USEPA, 2008).	38	c	USEPA EcoSSL for plants (USEPA, 2008).	210	130	41	Background (See Table D-1)
Selenium	7782-49-2	mg/kg	4.1	c	USEPA EcoSSL for invertebrates (USEPA, 2008).	0.52		USEPA EcoSSL for plants (USEPA, 2008).	1.2	0.63	0.82	Background (See Table D-1)
Silver	7440-22-4	mg/kg	2	d	USEPA (2001b) Region 4 Supplemental Guidance to Risk Assessment Guidance for Superfund	560	c	USEPA EcoSSL for plants (USEPA, 2008).	4.2	14	2	USEPA (2001b) Region 4 Supplemental Guidance to Risk Assessment Guidance for Superfund
Thallium	7440-28-0	mg/kg	1	d	USEPA (2001b) Region 4 Supplemental Guidance to Risk Assessment Guidance for Superfund	1		Efroymson et al., 1997b	--	--	1	USEPA (2001b) Region 4 Supplemental Guidance to Risk Assessment Guidance for Superfund
Vanadium	7440-62-2	mg/kg	1	e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	2		Efroymson et al., 1997b	7.8	280	90	Background (See Table D-1)
Zinc	7440-66-6	mg/kg	120		USEPA EcoSSL for invertebrates (USEPA, 2008).	160		USEPA EcoSSL for plants (USEPA, 2008).	46	79	84	Background (See Table D-1)
Volatile Organic Compounds (VOCs)												
1,1,1,2-Tetrachloroethane	630-20-6	mg/kg	--		--	--		--	--	--	--	--
1,1,1-Trichloroethane	71-55-6	mg/kg	5	e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--		--	--	--	5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
1,1,2,2-Tetrachloroethane	79-34-5	mg/kg	5	e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--		--	--	--	5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
1,1,2-Trichloroethane	79-00-5	mg/kg	5	e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--		--	--	--	5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
1,1-Dichloroethane	75-34-3	mg/kg	5	e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--		--	--	--	5	Canadian Environmental Quality Guidelines for Residential Soil (2006)

Table D-2
Soil Ecological Screening Levels

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			Soil Screening Levels							Primary Soil Screening Level [n]	
Constituent/Analytical Group	Cas. No.	Units	Invertebrate Contact Toxicity Benchmarks [a]	Source	Plant Contact Toxicity Benchmarks [b]	Source	Avian EcoSSL[c]	Mammalian EcoSSL[c]	Value	Source
1,1-Dichloroethene	75-35-4	mg/kg	5 e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
1,1-Dichloropropene	563-58-6	mg/kg	5 e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
1,2,3-Trichlorobenzene	87-61-6	mg/kg	20	Efroymson et al., 1997a	--	--	--	--	20	Efroymson et al., 1997a
1,2,3-Trichloropropane	96-18-4	mg/kg	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	120-82-1	mg/kg	20	Efroymson et al., 1997a	--	--	--	--	20	Efroymson et al., 1997a
1,2,4-Trimethylbenzene	95-63-6	mg/kg	--	--	--	--	--	--	--	--
1,2-Dibromo-3-Chloropropane	96-12-8	mg/kg	--	--	--	--	--	--	--	--
1,2-Dibromoethane	106-93-4	mg/kg	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	95-50-1	mg/kg	1 e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	1	Canadian Environmental Quality Guidelines for Residential Soil (2006)
1,2-Dichloroethane	107-06-2	mg/kg	5 e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
1,2-Dichloropropane	78-87-5	mg/kg	700	Efroymson et al., 1997a	--	--	--	--	700	Efroymson et al., 1997a
1,3,5-Trimethylbenzene	108-67-8	mg/kg	--	--	--	--	--	--	--	--
1,3-Dichlorobenzene	541-73-1	mg/kg	1 e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	1	Canadian Environmental Quality Guidelines for Residential Soil (2006)
1,3-Dichloropropane	142-28-9	mg/kg	--	--	--	--	--	--	--	--
1,4-Dichlorobenzene	106-46-7	mg/kg	20	Efroymson et al., 1997a	--	--	--	--	20	Efroymson et al., 1997a
2,2-Dichloropropane	594-20-7	mg/kg	--	--	--	--	--	--	--	--
2-Butanone	78-93-3	mg/kg	--	--	--	--	--	--	--	--
2-Chlorotoluene	95-49-8	mg/kg	--	--	--	--	--	--	--	--
4-Chlorotoluene	106-43-4	mg/kg	--	--	--	--	--	--	--	--
4-Methyl-2-Pentanone	108-10-1	mg/kg	--	--	--	--	--	--	--	--
Acetone	67-64-1	mg/kg	--	--	--	--	--	--	--	--
Benzene	71-43-2	mg/kg	0.5 f	Beyer (1990)	--	--	--	--	0.5	Beyer (1990)
Bromobenzene	108-86-1	mg/kg	--	--	--	--	--	--	--	--
Bromochloromethane	74-97-5	mg/kg	--	--	--	--	--	--	--	--
Bromodichloromethane	75-27-4	mg/kg	--	--	--	--	--	--	--	--
Bromoform	75-25-2	mg/kg	--	--	--	--	--	--	--	--
Bromomethane	74-83-9	mg/kg	--	--	--	--	--	--	--	--
Carbon Disulfide	75-15-0	mg/kg	--	--	--	--	--	--	--	--

Table D-2
Soil Ecological Screening Levels

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			Soil Screening Levels						Primary Soil Screening Level [n]	
Constituent/Analytical Group	Cas. No.	Units	Invertebrate Contact Toxicity Benchmarks [a]	Source	Plant Contact Toxicity Benchmarks [b]	Source	Avian EcoSSL[c]	Mammalian EcoSSL[c]	Value	Source
Carbon Tetrachloride	56-23-5	mg/kg	5 e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
Chlorinated Fluorocarbon (Freon 113)	76-13-1	mg/kg	--	--	--	--	--	--	--	--
Chlorobenzene	108-90-7	mg/kg	40	Efroymson et al., 1997a	--	--	--	--	40	Efroymson et al., 1997a
Chloroethane	75-00-3	mg/kg	--	--	--	--	--	--	--	--
Chloroform	67-66-3	mg/kg	5 e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
Chloromethane	74-87-3	mg/kg	--	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	156-59-2	mg/kg	5 e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
cis-1,3-Dichloropropene	10061-01-5	mg/kg	--	--	--	--	--	--	--	--
Dibromochloromethane	124-48-1	mg/kg	--	--	--	--	--	--	--	--
Dibromomethane	74-95-3	mg/kg	--	--	--	--	--	--	--	--
Dichlorodifluoromethane	75-71-8	mg/kg	--	--	--	--	--	--	--	--
Ethanol	64-17-5	mg/kg	--	--	--	--	--	--	--	--
Ethylbenzene	100-41-4	mg/kg	5 f	Beyer (1990)	--	--	--	--	5	Beyer (1990)
Hexachlorobutadiene	87-68-3	mg/kg	--	--	--	--	--	--	--	--
Isopropyl Alcohol	67-63-0	mg/kg	--	--	--	--	--	--	--	--
Isopropylbenzene	98-82-8	mg/kg	--	--	--	--	--	--	--	--
Methyl n-Butyl Ketone	591-78-6	mg/kg	--	--	--	--	--	--	--	--
Methylene Chloride	75-09-2	mg/kg	--	--	--	--	--	--	--	--
MTBE	1634-04-4	mg/kg	--	--	--	--	--	--	--	--
Naphthalene	91-20-3	mg/kg	5 f	Beyer (1990)	0.6 e	Canadian Environmental Quality Guidelines for Residential Soil (2006).	--	--	0.6	Canadian Environmental Quality Guidelines for Residential Soil (2006).
n-Butylbenzene	104-51-8	mg/kg	--	--	--	--	--	--	--	--
n-Propylbenzene	103-65-1	mg/kg	--	--	--	--	--	--	--	--
p-Isopropyl Toluene	99-87-6	mg/kg	--	--	--	--	--	--	--	--
sec-Butylbenzene	135-98-8	mg/kg	--	--	--	--	--	--	--	--
Styrene	100-42-5	mg/kg	5 e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	300	Efroymson et al., 1997b	--	--	5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
Tert-Butylbenzene	98-06-6	mg/kg	--	--	--	--	--	--	--	--
Tetrachloroethene	127-18-4	mg/kg	0.2 e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	0.2	Canadian Environmental Quality Guidelines for Residential Soil (2006)

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			Soil Screening Levels						Primary Soil Screening Level [n]	
Constituent/Analytical Group	Cas. No.	Units	Invertebrate Contact Toxicity Benchmarks [a]	Source	Plant Contact Toxicity Benchmarks [b]	Source	Avian EcoSSL[c]	Mammalian EcoSSL[c]	Value	Source
Toluene	108-88-3	mg/kg	3 [f]	Beyer (1990)	200	Efroymson et al., 1997b	--	--	3	Beyer (1990)
trans-1,2-Dichloroethene	156-60-5	mg/kg	5 [e]	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
trans-1,3-Dichloropropene	10061-02-6	mg/kg	--	--	--	--	--	--	--	--
Trichloroethene	79-01-6	mg/kg	5 [e]	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
Trichlorofluoromethane	75-69-4	mg/kg	--	--	--	--	--	--	--	--
Vinyl Acetate	108-05-4	mg/kg	--	--	--	--	--	--	--	--
Vinyl Chloride	75-01-4	mg/kg	--	--	--	--	--	--	--	--
Xylenes, m,p-	1330-20-7	mg/kg	11 [e]	Canadian Environmental Quality Guidelines for Residential Soil (2006)	1 [g]	USEPA Reg. 5 RCRA ESLs (2003), derived from plant toxicity	--	--	1	USEPA Reg. 5 RCRA ESLs (2003), derived from plant toxicity
Xylenes, o-	95-47-6	mg/kg	--	--	--	--	--	--	--	--
Xylenes, Total	1330-20-7	mg/kg	11 [e]	Canadian Environmental Quality Guidelines for Residential Soil (2006)	1 [g]	USEPA Reg. 5 RCRA ESLs (2003), derived from plant toxicity	--	--	1	USEPA Reg. 5 RCRA ESLs (2003), derived from plant toxicity
Semivolatile Organic Compounds (SVOCs)										
1,2,4-Trichlorobenzene	120-82-1	mg/kg	20	Efroymson et al., 1997a	--	--	--	--	20	Efroymson et al., 1997a
1,2-Dichlorobenzene	95-50-1	mg/kg	1 [e]	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	1	Canadian Environmental Quality Guidelines for Residential Soil (2006)
1,3-Dichlorobenzene	541-73-1	mg/kg	1 [e]	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	1	Canadian Environmental Quality Guidelines for Residential Soil (2006)
1,4-Dichlorobenzene	106-46-7	mg/kg	20	Efroymson et al., 1997a	--	--	--	--	20	Efroymson et al., 1997a
2,3,4,6-Tetrachlorophenol	58-90-2	mg/kg	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	95-95-4	mg/kg	9	Efroymson et al., 1997a	4	Efroymson et al., 1997b	--	--	4	Efroymson et al., 1997b
2,4,6-Trichlorophenol	88-06-2	mg/kg	10	Efroymson et al., 1997a	--	--	--	--	10	Efroymson et al., 1997a
2,4-Dichlorophenol	120-83-2	mg/kg	0.5 [e]	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	0.5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
2,4-Dimethylphenol	105-67-9	mg/kg	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	51-28-5	mg/kg	--	--	20	Efroymson et al., 1997b	--	--	20	Efroymson et al., 1997b
2,4-Dinitrotoluene	121-14-2	mg/kg	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	606-20-2	mg/kg	--	--	--	--	--	--	--	--
2-Chloronaphthalene	91-58-7	mg/kg	--	--	--	--	--	--	--	--
2-Chlorophenol	95-57-8	mg/kg	0.5 [e]	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	0.5	Canadian Environmental Quality Guidelines for Residential Soil (2006)
2-Methylnaphthalene	91-57-6	mg/kg	--	--	-- --	--	--	--	--	--
2-Methylphenol	95-48-7	mg/kg	--	--	--	--	--	--	--	--

Table D-2
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Constituent/Analytical Group	Cas. No.	Units	Soil Screening Levels: Invertebrate Contact Toxicity Benchmarks [a]	Source	Plant Contact Toxicity Benchmarks [b]	Source	Avian EcoSSL[c]	Mammalian EcoSSL[c]	Primary Soil Screening Level [n]: Value	Source
2-Nitroaniline	88-74-4	mg/kg	--	--	--	--	--	--	--	--
2-Nitrophenol	88-75-5	mg/kg	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	91-94-1	mg/kg	--	--	--	--	--	--	--	--
3-Nitroaniline	99-09-2	mg/kg	--	--	--	--	--	--	--	--
4,6-Dinitro-2-Methylphenol	534-52-1	mg/kg	--	--	--	--	--	--	--	--
4-Bromophenyl-phenylether	101-55-3	mg/kg	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	59-50-7	mg/kg	--	--	--	--	--	--	--	--
4-Chloroaniline	106-47-8	mg/kg	--	--	--	--	--	--	--	--
4-Chlorophenyl-phenylether	7005-72-3	mg/kg	--	--	--	--	--	--	--	--
4-Methylphenol	106-44-5	mg/kg	--	--	--	--	--	--	--	--
4-Nitroaniline	100-01-6	mg/kg	--	--	--	--	--	--	--	--
4-Nitrophenol	100-02-7	mg/kg	7	Efroymson et al., 1997a	--	--	--	--	7	Efroymson et al., 1997a
Acenaphthene	83-32-9	mg/kg	5 i	Efroymson et al., 1997a	20	Efroymson et al., 1997b	--	--	5	Efroymson et al., 1997a
Acenaphthylene	208-96-8	mg/kg	5 i	Efroymson et al., 1997a	0.6 i	Efroymson et al., 1997b	--	--	0.6	Efroymson et al., 1997b
Anthracene	120-12-7	mg/kg	5 i	Efroymson et al., 1997a	0.6 i	Efroymson et al., 1997b	--	--	0.6	Efroymson et al., 1997b
Azobenzene	103-33-3	mg/kg	--	--	--	--	--	--	--	--
Benzo(a)anthracene	56-55-3	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Benzo(a)pyrene	50-32-8	mg/kg	1 f	Beyer (1990)	1.2 h	USEPA (1999) SL ERA Protocol for Hazardous Waste Combustion Facilites.	--	--	1	Beyer (1990)
Benzo(b)fluoranthene	205-99-2	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Benzo(g,h,i)perylene	191-24-2	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Benzo(k)fluoranthene	207-08-9	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Benzoic acid	65-85-0	mg/kg	--	--	--	--	--	--	--	--
Benzyl Alcohol	100-51-6	mg/kg	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)Methane	111-91-1	mg/kg	--	--	--	--	--	--	--	--
bis(2-Chloroethyl)Ether	111-44-4	mg/kg	--	--	--	--	--	--	--	--
bis(2-Chloroisopropyl)ether	39638-32-9	mg/kg	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl)Phthalate	117-81-7	mg/kg	--	--	--	--	--	--	--	--
Butyl Benzyl Phthalate	85-68-7	mg/kg	--	--	--	--	--	--	--	--
Chrysene	218-01-9	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Dibenz(a,h)anthracene	53-70-3	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a

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Constituent/Analytical Group	Cas. No.	Units	Soil Screening Levels						Primary Soil Screening Level [n]	
			Invertebrate Contact Toxicity Benchmarks [a]	Source	Plant Contact Toxicity Benchmarks [b]	Source	Avian EcoSSL[c]	Mammalian EcoSSL[c]	Value	Source
Dibenzofuran	132-64-9	mg/kg	5 i	Efroymson et al., 1997a	0.6 i	Efroymson et al., 1997b	--	--	0.6	Efroymson et al., 1997b
Diethylphthalate	84-66-2	mg/kg	--	--	100	Efroymson et al., 1997b	--	--	100	Efroymson et al., 1997b
Dimethylphthalate	131-11-3	mg/kg	200	Efroymson et al., 1997a	--	--	--	--	200	Efroymson et al., 1997a
Di-n-butylphthalate	84-74-2	mg/kg	--	--	200	Efroymson et al., 1997b	--	--	200	Efroymson et al., 1997b
Di-n-octylphthalate	117-84-0	mg/kg	--	--	--	--	--	--	--	--
Fluoranthene	206-44-0	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Fluorene	86-73-7	mg/kg	30	Efroymson et al., 1997a	0.6 i	Efroymson et al., 1997b	--	--	0.6	Efroymson et al., 1997b
Hexachlorobenzene	118-74-1	mg/kg	2 e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	2	Canadian Environmental Quality Guidelines for Residential Soil (2006)
Hexachlorobutadiene	87-68-3	mg/kg	--	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	77-47-4	mg/kg	--	--	10	Efroymson et al., 1997b	--	--	10	Efroymson et al., 1997b
Hexachloroethane	67-72-1	mg/kg	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)Pyrene	193-39-5	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Isophorone	78-59-1	mg/kg	--	--	--	--	--	--	--	--
Naphthalene	91-20-3	mg/kg	5 f	Beyer (1990)	0.6 e	Canadian Environmental Quality Guidelines for Residential Soil (2006).	--	--	0.6	Canadian Environmental Quality Guidelines for Residential Soil (2006).
Nitrobenzene	98-95-3	mg/kg	40	Efroymson et al., 1997a	--	--	--	--	40	Efroymson et al., 1997a
n-Nitrosodimethylamine	62-75-9	mg/kg	--	--	--	--	--	--	--	--
n-Nitroso-di-n-propylamine	621-64-7	mg/kg	--	--	--	--	--	--	--	--
n-Nitrosodiphenylamine	86-30-6	mg/kg	20	Efroymson et al., 1997a	--	--	--	--	20	Efroymson et al., 1997a
Pentachlorophenol	87-86-5	mg/kg	31 c	USEPA EcoSSL for invertebrates (USEPA, 2007f).	5 c	USEPA EcoSSL for invertebrates (USEPA, 2007).	2.1	2.8	2.1	USEPA EcoSSL for avians (USEPA, 2008)
Phenanthrene	85-01-8	mg/kg	5 f	Beyer (1990)	0.6 i	Efroymson et al., 1997b	--	--	0.6	Efroymson et al., 1997b
Phenol	108-95-2	mg/kg	30	Efroymson et al., 1997a	70	Efroymson et al., 1997b	--	--	30	Efroymson et al., 1997a
Pyrene	129-00-0	mg/kg	10 f	Beyer (1990)	1.2 j	Efroymson et al., 1997b	--	--	1.2	Efroymson et al., 1997b
Resorcinol	108-46-3	mg/kg	--	--	--	--	--	--	--	--
LMW PAH	NA	mg/kg	29	USEPA EcoSSL for invertebrates (USEPA, 2008).	--	USEPA (1999) SL ERA Protocol for Hazardous Waste Combustion Facilites; Benzo(a)pyrene used as surrogate	--	100	29	USEPA EcoSSL for invertebrates (USEPA, 2008).
HMW PAH	NA	mg/kg	18	USEPA EcoSSL for invertebrates (USEPA, 2008).	--	Efroymson et al., 1997b; Naphthalene used as surrogate	--	1.1	1.1	USEPA EcoSSL for mammals (USEPA, 2008)
Total PAH	NA	mg/kg	--	--	--	--	--	--	--	--
USEPA B(a)P TEQ	NA	mg/kg	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)										

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2-Methylnaphthalene	91-57-6	mg/kg	--	--	--	--	--	--	--	--
Acenaphthene	83-32-9	mg/kg	5 i	Efroymson et al., 1997a	20	Efroymson et al., 1997b	--	--	5	Efroymson et al., 1997a
Acenaphthylene	208-96-8	mg/kg	5 i	Efroymson et al., 1997a	0.6 i	Efroymson et al., 1997b	--	--	0.6	Efroymson et al., 1997b
Anthracene	120-12-7	mg/kg	5 i	Efroymson et al., 1997a	0.6 i	Efroymson et al., 1997b	--	--	0.6	Efroymson et al., 1997b
Benzo(a)anthracene	56-55-3	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Benzo(a)pyrene	50-32-8	mg/kg	1 f	Beyer (1990)	1.2 h	USEPA (1999) SL ERA Protocol for Hazardous Waste Combustion Facilites.	--	--	1	Beyer (1990)
Benzo(b)fluoranthene	205-99-2	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Benzo(g,h,i)perylene	191-24-2	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Benzo(k)fluoranthene	207-08-9	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Chrysene	218-01-9	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Dibenz(a,h)anthracene	53-70-3	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Fluoranthene	206-44-0	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Fluorene	86-73-7	mg/kg	30	Efroymson et al., 1997a	0.6 i	Efroymson et al., 1997b	--	--	0.6	Efroymson et al., 1997b
Indeno(1,2,3-cd)Pyrene	193-39-5	mg/kg	1 j	Efroymson et al., 1997a	1.2 j	Efroymson et al., 1997b	--	--	1	Efroymson et al., 1997a
Naphthalene	91-20-3	mg/kg	5 f	Beyer (1990)	0.6 e	Canadian Environmental Quality Guidelines for Residential Soil (2006).	--	--	0.6	Canadian Environmental Quality Guidelines for Residential Soil (2006).
Phenanthrene	85-01-8	mg/kg	5 f	Beyer (1990)	0.6 i	Efroymson et al., 1997b	--	--	0.6	Efroymson et al., 1997b
Pyrene	129-00-0	mg/kg	10 f	Beyer (1990)	1.2 j	Efroymson et al., 1997b	--	--	1.2	Efroymson et al., 1997b
LMW PAH	NA	mg/kg	18	USEPA EcoSSL for invertebrates (USEPA, 2008).	--	--	--	100	18	USEPA EcoSSL for invertebrates (USEPA, 2008).
HMW PAH	NA	mg/kg	29	USEPA EcoSSL for invertebrates (USEPA, 2008).	--	--	--	1.1	1.1	USEPA EcoSSL for mammals (USEPA, 2008)
Total PAH	NA	mg/kg	--	--	--	--	--	--	--	--
USEPA B(a)P TEQ	NA	mg/kg	--	--	--	--	--	--	--	--
Organochlorine Pesticides										
4,4'-DDD	72-54-8	mg/kg	0.7 e,k	Canadian Environmental Quality Guidelines for Residential Soil (2006).	--	--	--	--	0.7	Canadian Environmental Quality Guidelines for Residential Soil (2006).
4,4'-DDE	72-55-9	mg/kg	0.7 e,k	Canadian Environmental Quality Guidelines for Residential Soil (2006).	--	--	--	--	0.7	Canadian Environmental Quality Guidelines for Residential Soil (2006).
4,4'-DDT	50-29-3	mg/kg	0.7 e,k	Canadian Environmental Quality Guidelines for Residential Soil (2006).	--	--	0.093	0.021	0.021	USEPA EcoSSL for mammals (USEPA, 2008)
Aldrin	309-00-2	mg/kg	--	--	0.00332 g	USEPA Reg. 5 RCRA ESLs (2003), derived from plant toxicity	--	--	0.00332	USEPA Reg. 5 RCRA ESLs (2003), derived from plant toxicity
Alpha-BHC	319-84-6	mg/kg	--	--	--	--	--	--	--	--

Table D-2
Soil Ecological Screening Levels

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Constituent/Analytical Group	Cas. No.	Units	Soil Screening Levels: Invertebrate Contact Toxicity Benchmarks [a]	Source	Plant Contact Toxicity Benchmarks [b]	Source	Avian EcoSSL [c]	Mammalian EcoSSL [c]	Primary Soil Screening Level [n]: Value	Source
Alpha-Chlordane	5103-71-9	mg/kg	--	--	--	--	--	--	--	--
Atrazine	1912-24-9	mg/kg	--	--	--	--	--	--	--	--
Beta-BHC	319-85-7	mg/kg	--	--	0.00398 g	USEPA Reg. 5 RCRA ESLs (2003), derived from plant toxicity	--	--	0.00398	USEPA Reg. 5 RCRA ESLs (2003), derived from plant toxicity
Delta-BHC	319-86-8	mg/kg	--	--	--	--	--	--	--	--
Dieldrin	60-57-1	mg/kg	0.05 l		--	--	0.022	0.0049	0.0049	USEPA EcoSSL for mammals (USEPA, 2008)
Endosulfan I	959-98-8	mg/kg	--	--	--	--	--	--	--	--
Endosulfan II	33213-65-9	mg/kg	--	--	--	--	--	--	--	--
Endosulfan Sulfate	1031-07-8	mg/kg	--	--	--	--	--	--	--	--
Endrin	72-20-8	mg/kg	0.0029 l		--	--	--	--	0.0029	0
Endrin Aldehyde	7421-93-4	mg/kg	--	--	--	--	--	--	--	--
Endrin Ketone	53494-70-5	mg/kg	--	--	--	--	--	--	--	--
Gamma-Chlordane	5103-74-2	mg/kg	--	--	--	--	--	--	--	--
Heptachlor	76-44-8	mg/kg	--	--	-- h	--	--	--	--	--
Heptachlor Epoxide	1024-57-3	mg/kg	--	--	--	--	--	--	--	--
HCH (gamma) Lindane	58-89-9	mg/kg	--	--	0.005 g	USEPA Reg. 5 RCRA ESLs (2003), derived from plant toxicity	--	--	0.005	USEPA Reg. 5 RCRA ESLs (2003), derived from plant toxicity
Methoxychlor	72-43-5	mg/kg	--	--	--	--	--	--	--	--
Propiconazole	60207-90-1	mg/kg	--	--	--	--	--	--	--	--
Toxaphene	8001-35-2	mg/kg	--	--	--	--	--	--	--	--
Triphenyl phosphate	115-86-6	mg/kg	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)										
Aroclor-1016	12674-11-2	mg/kg	-- --	--	-- --	--	--	--	--	--
Aroclor-1221	11104-28-2	mg/kg	-- --	--	-- --	--	--	--	--	--
Aroclor-1232	11141-16-5	mg/kg	-- --	--	-- --	--	--	--	--	--
Aroclor-1242	53469-21-9	mg/kg	-- --	--	-- --	--	--	--	--	--
Aroclor-1248	12672-29-6	mg/kg	-- --	--	-- --	--	--	--	--	--
Aroclor-1254	11097-69-1	mg/kg	-- --	--	-- --	--	--	--	--	--
Aroclor-1260	11096-82-5	mg/kg	-- --	--	-- --	--	--	--	--	--
Aroclor-1268	11100-14-4	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 8	34883-43-7	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 18	37680-65-2	mg/kg	-- --	--	-- --	--	--	--	--	--

Table D-2
Soil Ecological Screening Levels

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			Soil Screening Levels						Primary Soil Screening Level [n]	
Constituent/Analytical Group	Cas. No.	Units	Invertebrate Contact Toxicity Benchmarks [a]	Source	Plant Contact Toxicity Benchmarks [b]	Source	Avian EcoSSL[c]	Mammalian EcoSSL[c]	Value	Source
PCB# 28	7012-37-5	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 44	41464-39-5	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 52	35693-99-3	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 66	32598-10-0	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 77	32598-13-3	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 81	70362-50-4	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 101	37680-73-2	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 105	32598-14-4	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 114	74472-37-0	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 118	31508-00-6	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 123	65510-44-3	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 126	57465-28-8	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 128	38380-07-3	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 138	35065-28-2	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 153	35065-27-1	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 156	38380-08-4	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 157	69782-90-7	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 167	52663-72-6	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 169	32774-16-6	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 170	35065-30-6	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 180	35065-29-3	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 187	52663-68-0	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 189	39635-31-9	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 195	52663-78-2	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 206	40186-72-9	mg/kg	-- --	--	-- --	--	--	--	--	--
PCB# 209	2051-24-3	mg/kg	-- --	--	-- --	--	--	--	--	--
Total PCB Aroclors	NA	mg/kg	-- --	--	-- --	--	--	--	--	--
Total PCBs	NA	mg/kg	1 --	Beyer (1990)	41 --	Efroymson et al., 1997b	--	--	1	Beyer (1990)
Dioxins and Furans										
2,3,7,8-TCDD TEQ	NA	pg/g	4 e	Canadian Environmental Quality Guidelines for Residential Soil (2006)	--	--	--	--	4	Canadian Environmental Quality Guidelines for Residential Soil (2006)

Table D-2
Soil Ecological Screening Levels

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			Soil Screening Levels						Primary Soil Screening Level [n]	
Constituent/Analytical Group	Cas. No.	Units	Invertebrate Contact Toxicity Benchmarks [a]	Source	Plant Contact Toxicity Benchmarks [b]	Source	Avian EcoSSL[c]	Mammalian EcoSSL[c]	Value	Source
2,3,7,8-TCDD (Dioxin)	1746-01-6	pg/g	--	--	--	--	--	--	--	--
1,2,3,7,8-PeCDD	40321-76-4	pg/g	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HxCDD	39227-28-6	pg/g	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HxCDD	57653-85-7	pg/g	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HxCDD	19408-74-3	pg/g	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HpCDD	35822-46-9	pg/g	--	--	--	--	--	--	--	--
OCDD	3268-87-9	pg/g	--	--	--	--	--	--	--	--
2,3,7,8-TCDF	51207-31-9	pg/g	--	--	--	--	--	--	--	--
1,2,3,7,8-PeCDF	57117-41-6	pg/g	--	--	--	--	--	--	--	--
2,3,4,7,8-PeCDF	57117-31-4	pg/g	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HxCDF	70648-26-9	pg/g	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HxCDF	57117-44-9	pg/g	--	--	--	--	--	--	--	--
2,3,4,6,7,8-HxCDF	60851-34-5	pg/g	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HxCDF	72918-21-9	pg/g	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HpCDF	67562-39-4	pg/g	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-HpCDF	55673-89-7	pg/g	--	--	--	--	--	--	--	--
OCDF	39001-02-0	pg/g	--	--	--	--	--	--	--	--

Table D-2 Notes
Soil Ecological Screening Levels

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Acronyms and Abbreviations:

-- = not availal	not available
CalEPA	California Environmental Protection Agency
Cas. No.	Chemical Abstract Service number
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyl trichloroethane
EcoSSL	Ecological Soil Screening Level
ESL	environmental screening level
HMW	high molecular weight
HxCDD	hexachlorodibenzo-p-dioxin
HxCDF	hexachlorodibenzofuran
LMW	low molecular weight
mg/kg	milligrams per kilogram
MTBE	methyl tertiary-butyl ether
OCDD	octachlorodibenzo-p-dioxin
OCDF	octachlorodibenzofuran
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PeCDD	pentachlorodibenzo-p-dioxin
PeCDF	pentachlorodibenzofuran
pg/g	picograms per gram
pg/L	picograms per liter
SVOC	semivolatile organic compound
TEQ	toxic equivalent
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

Notes:

a. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process (Efroymson et al., 1997a) unless otherwise noted.
b. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants (Efroymson et al., 1997b) unless otherwise noted.
c. USEPA EcoSSL (USEPA, 2008).
d. From USEPA (2001) Region 4 Supplemental Guidance to Risk Assessment Guidance for Superfund.
e. From Canadian Environmental Quality Guidelines for Residential Soil (2006).
f. Beyer (1990) - "B" values, toxicity data indicate need for further assessment.
g. USEPA Region 5 Resource Conservation and Recovery Act Environmental Screening Levels (2003), derived from plant toxicity data.
h. From USEPA (1999) Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilites.
i. Naphthalene used as surrogate for low molecular weight PAHs.
j. Benzo(a)pyrene used as surrogate for high molecular weight PAHs.
k. Total DDT used as surrogate.
l. From Maximum Permissible Concentrations and Negligible Concentrations for Organics (Crommentuijn et al., 2000).
m. Value for chromium III
n. Primary screening level was the more conservative of the soil screening levels, except for metals where this value was below the background screening levels presented in Table D-1, in which case the background screening level was used as the PSL.

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Table D-3
Sediment Ecological Screening Levels

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			Sediment Screening Levels				Primary Sediment Screening Level	
Constituent/Analytical Group	CAS No.	Units	TEC [a]	Source	PEC [a]	Source	Value	Source
Metals								
Antimony	7440-36-0	mg/kg	--	--	--	--	--	--
Arsenic	7440-38-2	mg/kg	9.79	MacDonald et al. (2000)	33	MacDonald et al. (2000)	9.79	MacDonald et al. (2000)
Barium	7440-39-3	mg/kg	--	--	--	--	--	--
Beryllium	7440-41-7	mg/kg	--	--	--	--	--	--
Cadmium	7440-43-9	mg/kg	0.99	MacDonald et al. (2000)	4.98	MacDonald et al. (2000)	0.99	MacDonald et al. (2000)
Chromium	7440-47-3	mg/kg	43.4 j	MacDonald et al. (2000)	111 j	MacDonald et al. (2000)	43.4	MacDonald et al. (2000)
Chromium (VI)	18540-29-9	mg/kg	--	--	--	--	--	--
Cobalt	7440-48-4	mg/kg	20 c	Dutch MHSPE Target and Intervention Values (1994).	50 d	USEPA Region 5 Ecological Screening Levels (2003), based on EqP approach.	20	Dutch MHSPE Target and Intervention Values (1994).
Copper	7440-50-8	mg/kg	31.6	MacDonald et al. (2000)	149	MacDonald et al. (2000)	31.6	MacDonald et al. (2000)
Lead	7439-92-1	mg/kg	35.8	MacDonald et al. (2000)	128	MacDonald et al. (2000)	35.8	MacDonald et al. (2000)
Mercury	7439-97-6	mg/kg	0.18	MacDonald et al. (2000)	1.06	MacDonald et al. (2000)	0.18	MacDonald et al. (2000)
Molybdenum	7439-98-7	mg/kg	3 c	Dutch MHSPE Target and Intervention Values (1994).	250 c	Dutch MHSPE Target and Intervention Values (1994).	3	Dutch MHSPE Target and Intervention Values (1994).
Nickel	7440-02-0	mg/kg	22.7	MacDonald et al. (2000)	48.6	MacDonald et al. (2000)	22.7	MacDonald et al. (2000)
Selenium	7782-49-2	mg/kg	--	--	--	--	--	--
Silver	7440-22-4	mg/kg	0.5 e	Lowest Effect Level (Persaud et al., 1993).	--	--	0.5	Lowest Effect Level (Persaud et al., 1993).
Thallium	7440-28-0	mg/kg	--	--	--	--	--	--
Vanadium	7440-62-2	mg/kg	--	--	--	--	--	--
Zinc	7440-66-6	mg/kg	121	MacDonald et al. (2000)	459	MacDonald et al. (2000)	121	MacDonald et al. (2000)
Volatile Organic Compounds (VOCs)								
1,1,1,2-Tetrachloroethane	630-20-6	mg/kg	--	--	--	--	--	--
1,1,1-Trichloroethane	71-55-6	mg/kg	0.213 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.213	USEPA Reg. 5 ESLs (2003), based on EqP approach.
1,1,2,2-Tetrachloroethane	79-34-5	mg/kg	0.85 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.85	USEPA Reg. 5 ESLs (2003), based on EqP approach.
1,1,2-Trichloroethane	79-00-5	mg/kg	0.518 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.518	USEPA Reg. 5 ESLs (2003), based on EqP approach.
1,1-Dichloroethane	75-34-3	mg/kg	0.00058 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.000575	USEPA Reg. 5 ESLs (2003), based on EqP approach.
1,1-Dichloroethene	75-35-4	mg/kg	0.0194 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0194	USEPA Reg. 5 ESLs (2003), based on EqP approach.
1,1-Dichloropropene	563-58-6	mg/kg	--	--	--	--	--	--
1,2,3-Trichlorobenzene	87-61-6	mg/kg	--	--	--	--	--	--
1,2,3-Trichloropropane	96-18-4	mg/kg	--	--	--	--	--	--
1,2,4-Trichlorobenzene	120-82-1	mg/kg	5.062 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	5.062	USEPA Reg. 5 ESLs (2003), based on EqP approach.
1,2,4-Trimethylbenzene	95-63-6	mg/kg	--	--	--	--	--	--
1,2-Dibromo-3-Chloropropane	96-12-8	mg/kg	--	--	--	--	--	--
1,2-Dibromoethane	106-93-4	mg/kg	--		--		--	--
1,2-Dichlorobenzene	95-50-1	mg/kg	0.294 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.294	USEPA Reg. 5 ESLs (2003), based on EqP approach.
1,2-Dichloroethane	107-06-2	mg/kg	0.26 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.26	USEPA Reg. 5 ESLs (2003), based on EqP approach.
1,2-Dichloropropane	78-87-5	mg/kg	0.333 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.333	USEPA Reg. 5 ESLs (2003), based on EqP approach.
1,3,5-Trimethylbenzene	108-67-8	mg/kg	--	--	--	--	--	--
1,3-Dichlorobenzene	541-73-1	mg/kg	1.315 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	1.315	USEPA Reg. 5 ESLs (2003), based on EqP approach.
1,3-Dichloropropane	142-28-9	mg/kg	--	--	--	--	--	--

Table D-3
Sediment Ecological Screening Levels

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			Sediment Screening Levels				Primary Sediment Screening Level	
Constituent/Analytical Group	CAS No.	Units	TEC [a]	Source	PEC [a]	Source	Value	Source
1,4-Dichlorobenzene	106-46-7	mg/kg	0.318 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.318	USEPA Reg. 5 ESLs (2003), based on EqP approach.
2,2-Dichloropropane	594-20-7	mg/kg	--	--	--	--	--	--
2-Butanone	78-93-3	mg/kg	--	--	--	--	--	--
2-Chlorotoluene	95-49-8	mg/kg	--	--	--	--	--	--
4-Chlorotoluene	106-43-4	mg/kg	--	--	--	--	--	--
4-Methyl-2-Pentanone	108-10-1	mg/kg	--	--	--	--	--	--
Acetone	67-64-1	mg/kg	0.0099 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	0.057 f	USEPA (1999) SL ERA Protocol for Hazardous Waste Combustion Facilities.	0.0099	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Benzene	71-43-2	mg/kg	0.142 d	USEPA Reg. 5 ESLs (2003), based on	--	--	0.142	USEPA Reg. 5 ESLs (2003),
Bromobenzene	108-86-1	mg/kg	--	--	--	--	--	--
Bromochloromethane	74-97-5	mg/kg	--	--	--	--	--	--
Bromodichloromethane	75-27-4	mg/kg	--	--	--	--	--	--
Bromoform	75-25-2	mg/kg	0.492 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.492	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Bromomethane	74-83-9	mg/kg	--	--	--	--	--	--
Carbon Disulfide	75-15-0	mg/kg	0.0239 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0239	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Carbon Tetrachloride	56-23-5	mg/kg	1.45 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	1.45	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Chlorinated Fluorocarbon (Freon 113)	76-13-1	mg/kg	--	--	--	--	--	--
Chlorobenzene	108-90-7	mg/kg	0.291 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.291	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Chloroethane	75-00-3	mg/kg	--	--	--	--	--	--
Chloroform	67-66-3	mg/kg	0.121 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.121	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Chloromethane	74-87-3	mg/kg	--	--	--	--	--	--
cis-1,2-Dichloroethene	156-59-2	mg/kg	--	--	--	--	--	--
cis-1,3-Dichloropropene	10061-01-5	mg/kg	--	--	--	--	--	--
Dibromochloromethane	124-48-1	mg/kg	--	--	--	--	--	--
Dibromomethane	74-95-3	mg/kg	--	--	--	--	--	--
Dichlorodifluoromethane	75-71-8	mg/kg	--	--	--	--	--	--
Ethanol	64-17-5	mg/kg	--	--	--	--	--	--
Ethylbenzene	100-41-4	mg/kg	0.175 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.175	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Hexachlorobutadiene	87-68-3	mg/kg	0.0265 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0265	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Isopropyl Alcohol	67-63-0	mg/kg	--	--	--	--	--	--
Isopropylbenzene	98-82-8	mg/kg	--	--	--	--	--	--
Methyl n-Butyl Ketone	591-78-6	mg/kg	--	--	--	--	--	--
Methylene Chloride	75-09-2	mg/kg	0.159 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.159	USEPA Reg. 5 ESLs (2003), based on EqP approach.
MTBE	1634-04-4	mg/kg	--	--	--	--	--	--
Naphthalene	91-20-3	mg/kg	0.176	MacDonald et al. (2000)	0.561	MacDonald et al. (2000)	0.176	MacDonald et al. (2000)
n-Butylbenzene	104-51-8	mg/kg	--	--	--	--	--	--
n-Propylbenzene	103-65-1	mg/kg	--	--	--	--	--	--
p-Isopropyl Toluene	99-87-6	mg/kg	--	--	--	--	--	--
sec-Butylbenzene	135-98-8	mg/kg	--	--	--	--	--	--
Styrene	100-42-5	mg/kg	0.254 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.254	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Tert-Butylbenzene	98-06-6	mg/kg	--	--	--	--	--	--

Table D-3
Sediment Ecological Screening Levels

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Constituent/Analytical Group	CAS No.	Units	Sediment Screening Levels					Primary Sediment Screening Level	
			TEC [a]		Source	PEC [a]	Source	Value	Source
Tetrachloroethene	127-18-4	mg/kg	0.99	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.99	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Toluene	108-88-3	mg/kg	1.22	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	1.22	USEPA Reg. 5 ESLs (2003), based on EqP approach.
trans-1,2-Dichloroethene	156-60-5	mg/kg	0.654	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.654	USEPA Reg. 5 ESLs (2003), based on EqP approach.
trans-1,3-Dichloropropene	10061-02-6	mg/kg	--		--	--	--	--	--
Trichloroethene	79-01-6	mg/kg	0.112	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.112	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Trichlorofluoromethane	75-69-4	mg/kg	--		--	--	--	--	--
Vinyl Acetate	108-05-4	mg/kg	--		--	--	--	--	--
Vinyl Chloride	75-01-4	mg/kg	0.202	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.202	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Xylenes, m,p-	1330-20-7	mg/kg	0.433	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.433	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Xylenes, o-	95-47-6	mg/kg	--		--	--	--	--	--
Xylenes, Total	1330-20-7	mg/kg	0.433	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.433	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Semivolatile Organic Compounds (SVOCs)									
1,2,4-Trichlorobenzene	120-82-1	mg/kg	5.062	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	5.062	USEPA Reg. 5 ESLs (2003), based on EqP approach.
1,2-Dichlorobenzene	95-50-1	mg/kg	0.294	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.294	USEPA Reg. 5 ESLs (2003), based on EqP approach.
1,3-Dichlorobenzene	541-73-1	mg/kg	1.315	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	1.315	USEPA Reg. 5 ESLs (2003), based on EqP approach.
1,4-Dichlorobenzene	106-46-7	mg/kg	0.318	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.318	USEPA Reg. 5 ESLs (2003), based on EqP approach.
2,3,4,6-Tetrachlorophenol	58-90-2	mg/kg	--		--	--	--	--	--
2,4,5-Trichlorophenol	95-95-4	mg/kg	--		--	--	--	--	--
2,4,6-Trichlorophenol	88-06-2	mg/kg	0.208	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.208	USEPA Reg. 5 ESLs (2003), based on EqP approach.
2,4-Dichlorophenol	120-83-2	mg/kg	0.0817	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0817	USEPA Reg. 5 ESLs (2003), based on EqP approach.
2,4-Dimethylphenol	105-67-9	mg/kg	0.304	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.304	USEPA Reg. 5 ESLs (2003), based on EqP approach.
2,4-Dinitrophenol	51-28-5	mg/kg	0.00621	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.00621	USEPA Reg. 5 ESLs (2003), based on EqP approach.
2,4-Dinitrotoluene	121-14-2	mg/kg	0.0144	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0144	USEPA Reg. 5 ESLs (2003), based on EqP approach.
2,6-Dinitrotoluene	606-20-2	mg/kg	0.0398	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0398	USEPA Reg. 5 ESLs (2003), based on EqP approach.
2-Chloronaphthalene	91-58-7	mg/kg	0.417	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.417	USEPA Reg. 5 ESLs (2003), based on EqP approach.
2-Chlorophenol	95-57-8	mg/kg	0.0319	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0319	USEPA Reg. 5 ESLs (2003), based on EqP approach.
2-Methylnaphthalene	91-57-6	mg/kg	0.0202	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0202	USEPA Reg. 5 ESLs (2003), based on EqP approach.
2-Methylphenol	95-48-7	mg/kg	--		--	--	--	--	--
2-Nitroaniline	88-74-4	mg/kg	--		--	--	--	--	--
2-Nitrophenol	88-75-5	mg/kg	--		--	--	--	--	--
3,3'-Dichlorobenzidine	91-94-1	mg/kg	0.127	d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.127	USEPA Reg. 5 ESLs (2003), based on EqP approach.

Table D-3
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			Sediment Screening Levels				Primary Sediment Screening Level	
Constituent/Analytical Group	CAS No.	Units	TEC [a]	Source	PEC [a]	Source	Value	Source
3-Nitroaniline	99-09-2	mg/kg	--	--	--	--	--	--
4,6-Dinitro-2-Methylphenol	534-52-1	mg/kg	0.104 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.104	USEPA Reg. 5 ESLs (2003), based on EqP approach.
4-Bromophenyl-phenylether	101-55-3	mg/kg	1.55 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	1.55	USEPA Reg. 5 ESLs (2003), based on EqP approach.
4-Chloro-3-Methylphenol	59-50-7	mg/kg	--	--	--	--	--	--
4-Chloroaniline	106-47-8	mg/kg	0.146 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.146	USEPA Reg. 5 ESLs (2003), based on EqP approach.
4-Chlorophenyl-phenylether	7005-72-3	mg/kg	--	--	--	--	--	--
4-Methylphenol	106-44-5	mg/kg	--	--	--	--	--	--
4-Nitroaniline	100-01-6	mg/kg	--	--	--	--	--	--
4-Nitrophenol	100-02-7	mg/kg	0.0133 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0133	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Acenaphthene	83-32-9	mg/kg	0.00671 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.00671	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Acenaphthylene	208-96-8	mg/kg	0.00587 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.00587	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Anthracene	120-12-7	mg/kg	0.0572	MacDonald et al. (2000)	0.845	MacDonald et al. (2000)	0.0572	MacDonald et al. (2000)
Azobenzene	103-33-3	mg/kg	--	--	--	--	--	--
Benzo(a)anthracene	56-55-3	mg/kg	0.108	MacDonald et al. (2000)	1.05	MacDonald et al. (2000)	0.108	MacDonald et al. (2000)
Benzo(a)pyrene	50-32-8	mg/kg	0.15	MacDonald et al. (2000)	1.45	MacDonald et al. (2000)	0.15	MacDonald et al. (2000)
Benzo(b)fluoranthene	205-99-2	mg/kg	10.4 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	10.4	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Benzo(g,h,i)perylene	191-24-2	mg/kg	0.17 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	3.2 g	(Persaud et al., 1993)	0.17	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Benzo(k)fluoranthene	207-08-9	mg/kg	0.24 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	13.4 f	USEPA (1999) SL ERA Protocol for Hazardous Waste Combustion Facilities.	0.24	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Benzoic acid	65-85-0	mg/kg	--	--	--	--	--	--
Benzyl Alcohol	100-51-6	mg/kg	0.00104 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.00104	USEPA Reg. 5 ESLs (2003), based on EqP approach.
bis(2-Chloroethoxy)Methane	111-91-1	mg/kg	--	--	--	--	--	--
bis(2-Chloroethyl)Ether	111-44-4	mg/kg	3.52 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	3.52	USEPA Reg. 5 ESLs (2003), based on EqP approach.
bis(2-Chloroisopropyl)ether	39638-32-9	mg/kg	--	--	--	--	--	--
bis(2-Ethylhexyl)Phthalate	117-81-7	mg/kg	0.182 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.182	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Butyl Benzyl Phthalate	85-68-7	mg/kg	1.97 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	1.97	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Chrysene	218-01-9	mg/kg	0.166	MacDonald et al. (2000)	1.29	MacDonald et al. (2000)	0.166	MacDonald et al. (2000)
Dibenz(a,h)anthracene	53-70-3	mg/kg	0.033	MacDonald et al. (2000)	1.3 f	USEPA (1999) SL ERA Protocol for Hazardous Waste Combustion Facilities.	0.033	MacDonald et al. (2000)
Dibenzofuran	132-64-9	mg/kg	0.449 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.449	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Diethylphthalate	84-66-2	mg/kg	--	--	--	--	--	--
Dimethylphthalate	131-11-3	mg/kg	--	--	--	--	--	--
Di-n-butylphthalate	84-74-2	mg/kg	1.114 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	1.114	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Di-n-octylphthalate	117-84-0	mg/kg	40.6 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	40.6	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Fluoranthene	206-44-0	mg/kg	0.423	MacDonald et al. (2000)	2.23	MacDonald et al. (2000)	0.423	MacDonald et al. (2000)
Fluorene	86-73-7	mg/kg	0.0774	MacDonald et al. (2000)	0.536	MacDonald et al. (2000)	0.0774	MacDonald et al. (2000)

Table D-3
Sediment Ecological Screening Levels

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Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Sediment Screening Levels: TEC [a]	Sediment Screening Levels: Source	Sediment Screening Levels: PEC [a]	Sediment Screening Levels: Source	Primary Sediment Screening Level: Value	Primary Sediment Screening Level: Source
Hexachlorobenzene	118-74-1	mg/kg	0.02 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.02	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Hexachlorobutadiene	87-68-3	mg/kg	0.0265 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0265	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Hexachlorocyclopentadiene	77-47-4	mg/kg	0.901 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.901	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Hexachloroethane	67-72-1	mg/kg	0.584 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.584	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Indeno(1,2,3-cd)Pyrene	193-39-5	mg/kg	0.2 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	3.2 f	USEPA (1999) SL ERA Protocol for Hazardous Waste Combustion Facilities.	0.2	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Isophorone	78-59-1	mg/kg	0.432 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.432	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Naphthalene	91-20-3	mg/kg	0.176	MacDonald et al. (2000)	0.561	MacDonald et al. (2000)	0.176	MacDonald et al. (2000)
Nitrobenzene	98-95-3	mg/kg	0.145 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.145	USEPA Reg. 5 ESLs (2003), based on EqP approach.
n-Nitrosodimethylamine	62-75-9	mg/kg	--	--	--	--	--	--
n-Nitroso-di-n-propylamine	621-64-7	mg/kg	--	--	--	--	--	--
n-Nitrosodiphenylamine	86-30-6	mg/kg	--	--	--	--	--	--
Pentachlorophenol	87-86-5	mg/kg	23 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	23	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Phenanthrene	85-01-8	mg/kg	0.204	MacDonald et al. (2000)	1.17	MacDonald et al. (2000)	0.204	MacDonald et al. (2000)
Phenol	108-95-2	mg/kg	0.0491 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0491	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Pyrene	129-00-0	mg/kg	0.195	MacDonald et al. (2000)	1.52	MacDonald et al. (2000)	0.195	MacDonald et al. (2000)
Resorcinol	108-46-3	mg/kg	--	--	--	--	--	--
Total PAH	NA	mg/kg	1.61	MacDonald et al. (2000)	22.8	MacDonald et al. (2000)	1.61	MacDonald et al. (2000)
USEPA B(a)P TEQ	NA	mg/kg	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)								
2-Methylnaphthalene	91-57-6	mg/kg	0.0202 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0202	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Acenaphthene	83-32-9	mg/kg	0.00671 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.00671	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Acenaphthylene	208-96-8	mg/kg	0.00587 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.00587	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Anthracene	120-12-7	mg/kg	0.0572	MacDonald et al. (2000)	0.845	MacDonald et al. (2000)	0.0572	MacDonald et al. (2000)
Benzo(a)anthracene	56-55-3	mg/kg	0.108	MacDonald et al. (2000)	1.05	MacDonald et al. (2000)	0.108	MacDonald et al. (2000)
Benzo(a)pyrene	50-32-8	mg/kg	0.15	MacDonald et al. (2000)	1.45	MacDonald et al. (2000)	0.15	MacDonald et al. (2000)
Benzo(b)fluoranthene	205-99-2	mg/kg	10.4 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	10.4	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Benzo(g,h,i)perylene	191-24-2	mg/kg	0.17 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	3.2 g	(Persaud et al., 1993)	0.17	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Benzo(k)fluoranthene	207-08-9	mg/kg	0.24 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	13.4 f	USEPA (1999) SL ERA Protocol for Hazardous Waste Combustion Facilities.	0.24	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Chrysene	218-01-9	mg/kg	0.166	MacDonald et al. (2000)	1.29	MacDonald et al. (2000)	0.166	MacDonald et al. (2000)
Dibenz(a,h)anthracene	53-70-3	mg/kg	0.033	MacDonald et al. (2000)	1.3 f	USEPA (1999) SL ERA Protocol for Hazardous Waste Combustion Facilities.	0.033	MacDonald et al. (2000)
Fluoranthene	206-44-0	mg/kg	0.423	MacDonald et al. (2000)	2.23	MacDonald et al. (2000)	0.423	MacDonald et al. (2000)
Fluorene	86-73-7	mg/kg	0.0774	MacDonald et al. (2000)	0.536	MacDonald et al. (2000)	0.0774	MacDonald et al. (2000)
Indeno(1,2,3-cd)Pyrene	193-39-5	mg/kg	0.2 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	3.2 f	USEPA (1999) SL ERA Protocol for Hazardous Waste Combustion Facilities.	0.2	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Naphthalene	91-20-3	mg/kg	0.176	MacDonald et al. (2000)	0.561	MacDonald et al. (2000)	0.176	MacDonald et al. (2000)
Phenanthrene	85-01-8	mg/kg	0.204	MacDonald et al. (2000)	1.17	MacDonald et al. (2000)	0.204	MacDonald et al. (2000)

Table D-3
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			Sediment Screening Levels				Primary Sediment Screening Level	
Constituent/Analytical Group	**CAS No.**	**Units**	**TEC [a]**	**Source**	**PEC [a]**	**Source**	**Value**	**Source**
Pyrene	129-00-0	mg/kg	0.195	MacDonald et al. (2000)	1.52	MacDonald et al. (2000)	0.195	MacDonald et al. (2000)
LMW PAH	NA	mg/kg	--		--		--	--
HMW PAH	NA	mg/kg	--		--		--	--
Total PAH	NA	mg/kg	1.61	MacDonald et al. (2000)	22.8	MacDonald et al. (2000)	1.61	MacDonald et al. (2000)
USEPA B(a)P TEQ	NA	mg/kg	--	--	--	--	--	--
Organochlorine Pesticides								
4,4'-DDD	72-54-8	mg/kg	0.00488	MacDonald et al. (2000)	0.028	MacDonald et al. (2000)	0.00488	MacDonald et al. (2000)
4,4'-DDE	72-55-9	mg/kg	0.00316	MacDonald et al. (2000)	0.0313	MacDonald et al. (2000)	0.00316	MacDonald et al. (2000)
4,4'-DDT	50-29-3	mg/kg	0.00416	MacDonald et al. (2000)	0.0629	MacDonald et al. (2000)	0.00416	MacDonald et al. (2000)
Aldrin	309-00-2	mg/kg	0.002 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	0.08 f	USEPA (1999) SL ERA Protocol for Hazardous Waste Combustion Facilities.	0.002	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Alpha-BHC	319-84-6	mg/kg	0.006 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	0.1 f	USEPA (1999) SL ERA Protocol for Hazardous Waste Combustion Facilities.	0.006	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Alpha-Chlordane	5103-71-9	mg/kg	--	--	--	--	--	--
Atrazine	1912-24-9	mg/kg	--	--	--	--	--	--
Beta-BHC	319-85-7	mg/kg	0.005 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	0.21 f	USEPA (1999) SL ERA Protocol for Hazardous Waste Combustion Facilities.	0.005	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Delta-BHC	319-86-8	mg/kg	71.5 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	71.5	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Dieldrin	60-57-1	mg/kg	0.0019	MacDonald et al. (2000)	0.0618	MacDonald et al. (2000)	0.0019	MacDonald et al. (2000)
Endosulfan I	959-98-8	mg/kg	--	--	--	--	--	--
Endosulfan II	33213-65-9	mg/kg	0.00194 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.00194	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Endosulfan Sulfate	1031-07-8	mg/kg	0.0346 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0346	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Endrin	72-20-8	mg/kg	0.00267 b	TEL and PEL NOAA (2006).	0.0624 b	TEL and PEL NOAA (2006).	0.00267	TEL and PEL NOAA (2006).
Endrin Aldehyde	7421-93-4	mg/kg	0.48 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.48	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Endrin Ketone	53494-70-5	mg/kg	--	--	--	--	--	--
Gamma-Chlordane	5103-74-2	mg/kg	--	--	--	--	--	--
Heptachlor	76-44-8	mg/kg	0.00065 c	Dutch MHSPE Target and Intervention Values (1994).	--	--	0.00065	Dutch MHSPE Target and Intervention Values (1994).
Heptachlor Epoxide	1024-57-3	mg/kg	0.00247	MacDonald et al. (2000)	0.016	MacDonald et al. (2000)	0.00247	MacDonald et al. (2000)
HCH (gamma) Lindane	58-89-9	mg/kg	0.00237	MacDonald et al. (2000)	0.00499	MacDonald et al. (2000)	0.00237	MacDonald et al. (2000)
Methoxychlor	72-43-5	mg/kg	0.0136 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.0136	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Propiconazole	60207-90-1	mg/kg	--	--	--	--	--	--
Toxaphene	8001-35-2	mg/kg	7.7E-05 d	USEPA Reg. 5 ESLs (2003), based on EqP approach.	--	--	0.000077	USEPA Reg. 5 ESLs (2003), based on EqP approach.
Triphenyl phosphate	115-86-6	mg/kg	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)								
Aroclor-1016	12674-11-2	mg/kg	--	--	--	--	--	--
Aroclor-1221	11104-28-2	mg/kg	--	--	--	--	--	--
Aroclor-1232	11141-16-5	mg/kg	--	--	--	--	--	--
Aroclor-1242	53469-21-9	mg/kg	--	--	--	--	--	--
Aroclor-1248	12672-29-6	mg/kg	--	--	--	--	--	--
Aroclor-1254	11097-69-1	mg/kg	--	--	--	--	--	--
Aroclor-1260	11096-82-5	mg/kg	--	--	--	--	--	--
Aroclor-1268	11100-14-4	mg/kg	--	--	--	--	--	--
PCB# 8	34883-43-7	mg/kg	--	--	--	--	--	--
PCB# 18	37680-65-2	mg/kg	--	--	--	--	--	--
PCB# 28	7012-37-5	mg/kg	--	--	--	--	--	--

Table D-3
Sediment Ecological Screening Levels

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

			Sediment Screening Levels				Primary Sediment Screening Level	
Constituent/Analytical Group	CAS No.	Units	TEC [a]	Source	PEC [a]	Source	Value	Source
PCB# 44	41464-39-5	mg/kg	--	--	--	--	--	--
PCB# 52	35693-99-3	mg/kg	--	--	--	--	--	--
PCB# 66	32598-10-0	mg/kg	--	--	--	--	--	--
PCB# 77	32598-13-3	mg/kg	--	--	--	--	--	--
PCB# 81	70362-50-4	mg/kg	--	--	--	--	--	--
PCB# 101	37680-73-2	mg/kg	--	--	--	--	--	--
PCB# 105	32598-14-4	mg/kg	--	--	--	--	--	--
PCB# 114	74472-37-0	mg/kg	--	--	--	--	--	--
PCB# 118	31508-00-6	mg/kg	--	--	--	--	--	--
PCB# 123	65510-44-3	mg/kg	--	--	--	--	--	--
PCB# 126	57465-28-8	mg/kg	--	--	--	--	--	--
PCB# 128	38380-07-3	mg/kg	--	--	--	--	--	--
PCB# 138	35065-28-2	mg/kg	--	--	--	--	--	--
PCB# 153	35065-27-1	mg/kg	--	--	--	--	--	--
PCB# 156	38380-08-4	mg/kg	--	--	--	--	--	--
PCB# 157	69782-90-7	mg/kg	--	--	--	--	--	--
PCB# 167	52663-72-6	mg/kg	--	--	--	--	--	--
PCB# 169	32774-16-6	mg/kg	--	--	--	--	--	--
PCB# 170	35065-30-6	mg/kg	--	--	--	--	--	--
PCB# 180	35065-29-3	mg/kg	--	--	--	--	--	--
PCB# 187	52663-68-0	mg/kg	--	--	--	--	--	--
PCB# 189	39635-31-9	mg/kg	--	--	--	--	--	--
PCB# 195	52663-78-2	mg/kg	--	--	--	--	--	--
PCB# 206	40186-72-9	mg/kg	--	--	--	--	--	--
PCB# 209	2051-24-3	mg/kg	--	--	--	--	--	--
Total PCBs	NA	mg/kg	0.0598	MacDonald et al. (2000)	0.678	MacDonald et al. (2000)	0.0598	MacDonald et al. (2000)
Dioxins and Furans								
2,3,7,8-TCDD TEQ	NA	pg/g	0.85 h,i	CCME	21.5 h,i	CCME	21.5	CCME [k]
2,3,7,8-TCDD (Dioxin)	1746-01-6	pg/g	0.85 h,i	CCME	21.5 h,i	CCME	21.5	CCME [k]
1,2,3,7,8-PeCDD	40321-76-4	pg/g	--	--	--	--	--	--
1,2,3,4,7,8-HxCDD	39227-28-6	pg/g	--	--	--	--	--	--
1,2,3,6,7,8-HxCDD	57653-85-7	pg/g	--	--	--	--	--	--
1,2,3,7,8,9-HxCDD	19408-74-3	pg/g	--	--	--	--	--	--
1,2,3,4,6,7,8-HpCDD	35822-46-9	pg/g	--	--	--	--	--	--
OCDD	3268-87-9	pg/g	--	--	--	--	--	--
2,3,7,8-TCDF	51207-31-9	pg/g	--	--	--	--	--	--
1,2,3,7,8-PeCDF	57117-41-6	pg/g	--	--	--	--	--	--
2,3,4,7,8-PeCDF	57117-31-4	pg/g	--	--	--	--	--	--
1,2,3,4,7,8-HxCDF	70648-26-9	pg/g	--	--	--	--	--	--
1,2,3,6,7,8-HxCDF	57117-44-9	pg/g	--	--	--	--	--	--
2,3,4,6,7,8-HxCDF	60851-34-5	pg/g	--	--	--	--	--	--
1,2,3,7,8,9-HxCDF	72918-21-9	pg/g	--	--	--	--	--	--
1,2,3,4,6,7,8-HpCDF	67562-39-4	pg/g	--	--	--	--	--	--
1,2,3,4,7,8,9-HpCDF	55673-89-7	pg/g	--	--	--	--	--	--
OCDF	39001-02-0	pg/g	--	--	--	--	--	--

Table D-3
Sediment Ecological Screening Levels

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

			Sediment Screening Levels				Primary Sediment Screening Level	
Constituent/Analytical Group	CAS No.	Units	TEC [a]	Source	PEC [a]	Source	Value	Source

Acronyms and Abbreviations:

-- = not available	not available
Cas. No.	Chemical Abstract Service number
CCME	Canadian Council of Ministers of the Environment
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyl trichloroethane
EqP	equilibrium partitioning (EqP) approach
ESL	environmental screening level
HMW	high molecular weight
HxCDD	hexachlorodibenzo-p-dioxin
HxCDF	hexachlorodibenzofuran
LMW	low molecular weight
mg/kg	milligrams per kilogram
MTBE	methyl tertiary-butyl ether
NA	not applicable
OCDD	octachlorodibenzo-p-dioxin
OCDF	octachlorodibenzofuran
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PEC	probable effects concentration
PeCDD	pentachlorodibenzo-p-dioxin
PeCDF	pentachlorodibenzofuran
pg/g	picograms per gram
SVOC	semivolatile organic compound
TEC	threshold effects concentration
TOC	volatile organic compound
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

Notes:

a. Sediment Screening Criteria are based on "Consensus-based TEC" and "Consensus-based PEC" taken from MacDonald et al. (2000) except when noted.
b. Threshold Effects Level (TEL) and Probable Effects Level (PEL) from NOAA (2006).
c. From Dutch MHSPE Target and Intervention Values (1994).
d. From USEPA Region 5 Ecological Screening Levels (2003), based on EqP approach.
e. Lowest Effect Level (Persaud et al., 1993).
f. From USEPA (1999) Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.
g. Severe Effects Level from Guidelines for the Protection and Management of Aquatic Sediment Quality, assuming 1% organic compounds (Persaud et al., 1993).
h. CCME (2002) Interim freshwater sediment quality guidelines and Probable Effects Levels.
i. Based on fish toxicity equivalency quotient from World Health Organization 1998 toxicity equivalency factor values (Van den Berg et al., 2006).
j. Value for chromium III
k. PEC used as primary screening level for 2,3,7,8-TCDD TEQ because TEC is below ambient levels.

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Table D-4
Groundwater Screening Levels

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Back-ground	Groundwater Screening Levels					Primary Screening Level	
				MCL	CA-RSL[a]	CA-RSL (11/2010) Source	PHG[b]	PRGtw-CA[c]	Value	Source
Metals										
Aluminum (fume or dust)	7429-90-5	µg/L	--	1000	37000	RSL	600	--	1000	MCL
Antimony	7440-36-0	µg/L	0.40	6	15	RSL	20	--	6	MCL
Arsenic	7440-38-2	µg/L	2.5	10	0.0071[f]	HERD	0.004	0.0071	10	MCL
Barium	7440-39-3	µg/L	25.6	1000	7300	RSL	2000	--	1000	MCL
Beryllium	7440-41-7	µg/L	0.44	4	73	RSL	1	--	4	MCL
Cadmium	7440-43-9	µg/L	0.5	5	18	RSL	0.04	--	5	MCL
Chromium	7440-47-3	µg/L	1.5	50[d]	55000	RSL	--	--	50	MCL[d]
Chromium (hexavalent)	18540-29-9	µg/L	--	--	0.043	RSL	--		0.043	RSL
Cobalt	7440-48-4	µg/L	0.64	--	11	RSL	--	--	11	RSL
Copper	7440-50-8	µg/L	1.5	1300	1500	RSL	300	--	1300	MCL
Iron	7439-89-6	µg/L	--	300	26000	RSL	--	--	300	MCL
Lead	7439-92-1	µg/L	1	15			0.2	--	15	MCL
Magnesium	7439-95-4	µg/L	--	--		--	--	--	--	--
Manganese	7439-96-5	µg/L	--	50	880	RSL	--	--	50	MCL
Mercury	7439-97-6	µg/L	NA	2	11[j]	RSL	1.2[e]	--	2	MCL
Molybdenum	7439-98-7	µg/L	0.91	--	180	RSL	--	--	180	RSL
Nickel	7440-02-0	µg/L	1.1	100	730	RSL	12	--	100	MCL
Selenium	7782-49-2	µg/L	0.57	50	180	RSL	--	--	50	MCL
Silver	7440-22-4	µg/L	0.36	100	180	RSL	--	--	100	MCL
Thallium	7440-28-0	µg/L	0.97	2		--	0.1	--	2	MCL
Vanadium	7440-62-2	µg/L	3	--	36	HERD	--	--	36	HERD
Zinc	7440-66-6	µg/L	12.2	5000	11000	RSL	--	--	5000	MCL
Volatile Organic Compounds (VOCs)										
1,1,1,2-Tetrachloroethane	630-20-6	µg/L	--	--	0.52	RSL	--	--	0.52	RSL
1,1,1-Trichloroethane	71-55-6	µg/L	--	200	9100	RSL	1000	--	200	MCL
1,1,2,2-Tetrachloroethane	79-34-5	µg/L	--	1	0.067	RSL	0.1	--	1	MCL
1,1,2-Trichloroethane	79-00-5	µg/L	--	5	0.24	RSL	0.3	--	5	MCL
1,1-Dichloroethane	75-34-3	µg/L	--	5	2.4	RSL	3	1.966	5	MCL
1,1-Dichloroethene	75-35-4	µg/L	--	6	340	RSL	10	--	6	MCL
1,1-Dichloropropene	563-58-6	µg/L	--	--		--	--	--	--	--
1,2,3-Trichlorobenzene	87-61-6	µg/L	--	--	29	RSL	--	--	29	RSL
1,2,3-Trichloropropane	96-18-4	µg/L	--	--	0.00072	RSL	--	--	0.00072	RSL
1,2,4-Trichlorobenzene	120-82-1	µg/L	--	5	2.3	RSL	5	--	5	MCL
1,2,4-Trimethylbenzene	95-63-6	µg/L	--	--	15	RSL	--	--	15	RSL
1,2-Dibromo-3-Chloropropane	96-12-8	µg/L	--	0.2	0.00032	RSL	0.0017	0.0016	0.2	MCL
1,2-Dichlorobenzene	95-50-1	µg/L	--	600	370	RSL	600	--	600	MCL

Table D-4
Groundwater Screening Levels

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Back-ground	Groundwater Screening Levels						Primary Screening Level	
				MCL	CA-RSL[a]		CA-RSL (11/2010) Source	PHG[b]	PRGtw-CA[c]	Value	Source
1,2-Dichloroethane	107-06-2	µg/L	--	0.5	0.15		RSL	0.4	--	0.5	MCL
1,2-Dichloropropane	78-87-5	µg/L	--	5	0.39		RSL	0.5	--	5	MCL
1,3,5-Trimethylbenzene	108-67-8	µg/L	--	--	370		RSL	--	--	370	RSL
1,3-Butadiene	106-99-0	µg/L	--	--	0.018	f	RSL	--	0.019	0.018	RSL
1,3-Dichlorobenzene	541-73-1	µg/L	--	--	180	g	HERD	--	--	180	HERD
1,3-Dichloropropane	142-28-9	µg/L	--	--	730		RSL	--	--	730	RSL
1,4-Dichlorobenzene	106-46-7	µg/L	--	5	0.43		RSL	6	--	5	MCL
2,2-Dichloropropane	594-20-7	µg/L	--	--			--	--	--	--	--
2-Butanone	78-93-3	µg/L	--	--	7100		RSL	--	--	7100	RSL
2-Chlorotoluene	95-49-8	µg/L	--	--	120	h	HERD	--	--	120	HERD
4-Chlorotoluene	106-43-4	µg/L	--	--	2600		RSL	--	--	2600	RSL
4-Methyl-2-Pentanone	108-10-1	µg/L	--	--	2000		RSL	--	--	2000	RSL
Acetone	67-64-1	µg/L	--	--	22000		RSL	--	--	22000	RSL
Benzene	71-43-2	µg/L	--	1	0.41		RSL	0.15	--	1	MCL
Bromobenzene	108-86-1	µg/L	--	--	88		RSL	--	--	88	RSL
Bromochloromethane	74-97-5	µg/L	--	--			--	--	--	--	--
Bromodichloromethane	75-27-4	µg/L	--	80	0.12	h	RSL	--	--	80	MCL
Bromoform	75-25-2	µg/L	--	80	8.5		RSL	--	--	80	MCL
Bromomethane	74-83-9	µg/L	--	--	8.7		RSL	--	--	8.7	RSL
Carbon Disulfide	75-15-0	µg/L	--	--	1000		RSL	--	--	1000	RSL
Carbon Tetrachloride	56-23-5	µg/L	--	0.5	0.44		RSL	0.1	--	0.5	MCL
Chlorinated Fluorocarbon (freon 113)	76-13-1	µg/L	--	1200	59000		RSL	4000	--	1200	MCL
Chlorobenzene	108-90-7	µg/L	--	70	91		RSL	200	--	70	MCL
Chloroethane	75-00-3	µg/L	--	--	4.6	i	HERD	--	--	4.6	HERD
Chloroform	67-66-3	µg/L	--	80	0.19		RSL	--	0.5336	80	MCL
Chloromethane	74-87-3	µg/L	--	--	190		RSL	--	--	190	RSL
cis-1,2-Dichloroethene	156-59-2	µg/L	--	6	73		RSL	100	--	6	MCL
cis-1,3-Dichloropropene	10061-01-5	µg/L	--	--	0.43		--	0.2	--	0.2	PHG
Dibromochloromethane	124-48-1	µg/L	--	80	0.15	h	RSL	--	--	80	MCL
Dibromomethane	74-95-3	µg/L	--	--	8.2	h	RSL	--	--	8.2	RSL
Dichlorodifluoromethane	75-71-8	µg/L	--	--	390		RSL	--	--	390	RSL
Ethanol	64-17-5	µg/L	--	--			--	--	--	--	--
Ethylbenzene	100-41-4	µg/L	--	300	1.5		RSL	300	--	300	MCL
Ethylene Dibromide	106-93-4	µg/L	--	0.05	0.0065		RSL	0.01	--	0.05	MCL
Hexachlorobutadiene	87-68-3	µg/L	--	--	0.86		RSL	--	--	0.86	RSL
Isopropyl alcohol (manufacturing-stro	67-63-0	µg/L	--	--			--	--	--	--	--

Table D-4
Groundwater Screening Levels

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Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Back-ground	Groundwater Screening Levels					Primary Screening Level	
				MCL	CA-RSL [a]	CA-RSL (11/2010) Source	PHG [b]	PRGtw-CA [c]	Value	Source
Isopropylbenzene	98-82-8	µg/L	--	--	680	RSL	--	--	680	RSL
m,p-Xylenes	1330-20-7	µg/L	--	1750	200	RSL	1800	--	1750	MCL
Methyl n-Butyl Ketone	591-78-6	µg/L	--	--	47	RSL	--	--	47	RSL
Methylene Chloride	75-09-2	µg/L	--	5	4.8	RSL	4	--	5	MCL
MTBE	1634-04-4	µg/L	--	13	12	RSL	13	--	13	MCL
n-Butylbenzene	104-51-8	µg/L	--	--	240 [f]	HERD	--	--	240	HERD
n-Propylbenzene	103-65-1	µg/L	--	--	240 [f]	HERD	--	--	240	HERD
o-xylene	95-47-6	µg/L	--	1750	1200	RSL	1800	--	1750	MCL
Para-Isopropyl Toluene	99-87-6	µg/L	--	--		--	--	--	--	--
sec-Butylbenzene	135-98-8	µg/L	--	--	240 [f]	HERD	--	--	240	HERD
Styrene	100-42-5	µg/L	--	100	1600	RSL	--	--	100	MCL
Tert-Butylbenzene	98-06-6	µg/L	--	--	240 [f]	HERD	--	--	240	HERD
Tetrachloroethene	127-18-4	µg/L	--	5	0.11	RSL	0.06	--	5	MCL
Toluene	108-88-3	µg/L	--	150	2300	RSL	150	--	150	MCL
trans-1,2-Dichloroethene	156-60-5	µg/L	--	10	110	RSL	60	--	10	MCL
trans-1,3-Dichloropropene	10061-02-6	µg/L	--	--	0.43	--	0.2	--	0.2	PHG
Trichloroethene	79-01-6	µg/L	--	5	2.0	RSL	1.7	1.4007	5	MCL
Trichlorofluoromethane (freon 11)	75-69-4	µg/L	--	150	1300	RSL	700	--	150	MCL
Vinyl Acetate	108-05-4	µg/L	--	--	410	RSL	--	--	410	RSL
Vinyl Chloride	75-01-4	µg/L	--	0.5	0.016	RSL	0.05	--	0.5	MCL
Xylenes, Total	1330-20-7	µg/L	--	1750	200	RSL	1800	--	1750	MCL
Polycyclic Aromatic Hydrocarbons (PAHs)										
Acenaphthene	83-32-9	µg/L	--	--	370 [h]	HERD	--	--	370	HERD
Acenaphthylene	208-96-8	µg/L	--	--		--	--	--	--	--
Anthracene	120-12-7	µg/L	--	--	1800 [h]	HERD	--	--	1800	HERD
Benzo(a)anthracene	56-55-3	µg/L	--	--	0.029	RSL	--	--	0.029	RSL
Benzo(a)pyrene	50-32-8	µg/L	--	0.2	0.0029	RSL	0.007	--	0.2	MCL
Benzo(b)fluoranthene	205-99-2	µg/L	--	--	0.029	RSL	--	--	0.029	RSL
Benzo(g,h,i)perylene	191-24-2	µg/L	--	--		--	--	--	--	--
Benzo(k)fluoranthene	207-08-9	µg/L	--	--	0.056 [f]	HERD	--	0.056	0.056	HERD
Chrysene	218-01-9	µg/L	--	--	0.56 [f]	HERD	--	0.5603	0.56	HERD
Dibenz(a,h)anthracene	53-70-3	µg/L	--	--	0.0029	RSL	--	--	0.0029	RSL
Fluoranthene	206-44-0	µg/L	--	--	1500	RSL	--	--	1500	RSL
Fluorene	86-73-7	µg/L	--	--	240 [h]	HERD	--	--	240	HERD
Indeno(1,2,3-cd)Pyrene	193-39-5	µg/L	--	--	0.029	RSL	--	--	0.029	RSL
Naphthalene	91-20-3	µg/L	--	--	0.14	RSL	--	0.093	0.14	RSL

Table D-4
Groundwater Screening Levels

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Back-ground	Groundwater Screening Levels: MCL	CA-RSL [a]	CA-RSL (11/2010) Source	PHG [b]	PRGtw-CA [c]	Primary Screening Level: Value	Primary Screening Level: Source
Phenanthrene	85-01-8	µg/L	--	--		--	--	--	--	--
Pyrene	129-00-0	µg/L	--	--	180 [h]	HERD	--	--	180	HERD
B(a)P TEQ	--	µg/L	--	0.2	--	--	0.007	--	0.2	MCL
Semivolatile Organic Compounds (SVOCs)										
2,4-Dichlorophenol	120-83-2	µg/L	--	--	110	RSL	--	--	110	RSL
2,4-Dimethylphenol	105-67-9	µg/L	--	--	730	RSL	--	--	730	RSL
2,4-Dinitrophenol	51-28-5	µg/L	--	--	73	RSL	--	--	73	RSL
2,4-Dinitrotoluene	121-14-2	µg/L	--	--	0.22	RSL	--	--	0.22	RSL
2,6-Dinitrotoluene	606-20-2	µg/L	--	--	37	RSL	--	--	37	RSL
2-Chloronaphthalene	91-58-7	µg/L	--	--	490 [h]	HERD	--	--	490	HERD
2-Chlorophenol	95-57-8	µg/L	--	--	30 [h]	HERD	--	--	30	HERD
2-Methylnaphthalene	91-57-6	µg/L	--	--	150	RSL	--	--	150	RSL
2-Methylphenol	95-48-7	µg/L	--	--	1800	RSL	--	--	1800	RSL
2-Nitroaniline	88-74-4	µg/L	--	--	370	RSL	--	--	370	RSL
2-Nitrophenol	88-75-5	µg/L	--	--		--	--	--	--	--
3,3'-Dichlorobenzidine	91-94-1	µg/L	--	--	0.15	RSL	--	--	0.15	RSL
3-Nitroaniline	99-09-2	µg/L	--	--		--	--	--		--
4,6-Dinitro-2-Methylphenol	534-52-1	µg/L	--	--	2.9	RSL	--	--	2.9	RSL
4-Bromophenyl-phenylether	101-55-3	µg/L	--	--		--	--	--		--
4-Chloro-3-Methylphenol	59-50-7	µg/L	--	--	3700	RSL	--	--	3700	RSL
4-Chloroaniline	106-47-8	µg/L	--	--	0.34	RSL	--	--	0.34	RSL
4-Chlorophenyl-phenylether	7005-72-3	µg/L	--	--		--	--	--		--
4-Methylphenol	106-44-5	µg/L	--	--	180	RSL	--	--	180	RSL
4-Nitroaniline	100-01-6	µg/L	--	--	3.4	RSL	--	--	3.4	RSL
4-Nitrophenol	100-02-7	µg/L	--	--		--	--	--	--	--
Azobenzene	103-33-3	µg/L	--	--	0.12	RSL	--	--	0.12	RSL
Benzoic acid	65-85-0	µg/L	--	--	150000	RSL	--	--	150000	RSL
Benzyl Alcohol	100-51-6	µg/L	--	--	3700	RSL	--	--	3700	RSL
bis(2-Chloroethoxy)Methane	111-91-1	µg/L	--	--	110	RSL	--	--	110	RSL
bis(2-Chloroethyl)Ether	111-44-4	µg/L	--	--	0.012	RSL	--	--	0.012	RSL
bis(2-Chloroisopropyl)ether	39638-32-9	µg/L	--	--		--	--	--	--	--
bis(2-Ethylhexyl)Phthalate	117-81-7	µg/L	--	4	4.8	RSL	12	--	4	MCL
Butyl Benzyl Phthalate	85-68-7	µg/L	--	--	35	RSL	--	--	35	RSL
Dibenzofuran	132-64-9	µg/L	--	--	12	HERD	--	--	12	HERD
Diethylphthalate	84-66-2	µg/L	--	--	29000	RSL	--	--	29000	RSL
Dimethylphthalate	131-11-3	µg/L	--	--	360000 [g]	HERD	--	--	360000	HERD
Di-n-butylphthalate	84-74-2	µg/L	--	--	3700	RSL	--	--	3700	RSL

Table D-4
Groundwater Screening Levels

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Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Back-ground	Groundwater Screening Levels					Primary Screening Level	
				MCL	CA-RSL[a]	CA-RSL (11/2010) Source	PHG [b]	PRGtw-CA [c]	Value	Source
Di-n-octylphthalate	117-84-0	µg/L	--	--	1500 [g]	HERD	--	--	1500	HERD
Hexachlorobenzene	118-74-1	µg/L	--	1	0.042	RSL	0.03	--	1	MCL
Hexachlorocyclopentadiene	77-47-4	µg/L	--	50	220	RSL	50	--	50	MCL
Hexachloroethane	67-72-1	µg/L	--	--	4.8	RSL	--	--	4.8	RSL
Isophorone	78-59-1	µg/L	--	--	71	RSL	--	--	71	RSL
Nitrobenzene	98-95-3	µg/L	--	--	0.12	RSL	--	--	0.12	RSL
N-Nitrosodimethylamine	62-75-9	µg/L	--	--	0.00042	RSL	0.003	--	0.003	PHG
N-Nitroso-di-n-propylamine	621-64-7	µg/L	--	--	0.0096	RSL	--	--	0.0096	RSL
N-Nitrosodiphenylamine	86-30-6	µg/L	--	--	14	RSL	--	--	14	RSL
Phenol	108-95-2	µg/L	--	--	11000	RSL	--	--	11000	RSL
Resorcinol	108-46-3	µg/L	--	--		--	--	--	--	--
Polychlorinated Biphenyls (PCBs)										
Arochlor-1016	12674-11-2	µg/L	--	--	0.96	RSL	--	--	0.96	RSL
Arochlor-1221	11104-28-2	µg/L	--	--	0.0068	RSL	--	--	0.0068	RSL
Arochlor-1232	11141-16-5	µg/L	--	--	0.0068	RSL	--	--	0.0068	RSL
Arochlor-1242	53469-21-9	µg/L	--	--	0.034	RSL	--	--	0.034	RSL
Arochlor-1248	12672-29-6	µg/L	--	--	0.034	RSL	--	--	0.034	RSL
Arochlor-1254	11097-69-1	µg/L	--	--	0.034	RSL	--	--	0.034	RSL
Arochlor-1260	11096-82-5	µg/L	--	--	0.034	RSL	--	--	0.034	RSL
Aroclor-1268	11100-14-4	µg/L	--	--		--	--	--	--	--
PCB 101	37680-73-2	µg/L	--	--		--	--	--	--	--
PCB 105	32598-14-4	µg/L	--	--	0.017	RSL	--	--	0.017	RSL
PCB 114	74472-37-0	µg/L	--	--	0.017	RSL	--	--	0.017	RSL
PCB 118	31508-00-6	µg/L	--	--	0.017	RSL	--	--	0.017	RSL
PCB 123	65510-44-3	µg/L	--	--	0.017	RSL	--	--	0.017	RSL
PCB 126	57465-28-8	µg/L	--	--	0.0000052	RSL	--	--	0.0000052	RSL
PCB 128	38380-07-3	µg/L	--	--		--	--	--	--	--
PCB 138	35065-28-2	µg/L	--	--		--	--	--	--	--
PCB 153	35065-27-1	µg/L	--	--		--	--	--	--	--
PCB 156	38380-08-4	µg/L	--	--	0.017	RSL	--	--	0.017	RSL
PCB 157	69782-90-7	µg/L	--	--	0.017	RSL	--	--	0.017	RSL
PCB 167	52663-72-6	µg/L	--	--	0.017	RSL	--	--	0.017	RSL
PCB 169	32774-16-6	µg/L	--	--	0.000017	RSL	--	--	0.000017	RSL
PCB 170	35065-30-6	µg/L	--	--		--	--	--	--	--
PCB 18	37680-65-2	µg/L	--	--		--	--	--	--	--
PCB 180	35065-29-3	µg/L	--	--		--	--	--	--	--
PCB 187	52663-68-0	µg/L	--	--		--	--	--	--	--
PCB 189	39635-31-9	µg/L	--	--	0.017	RSL	--	--	0.017	RSL

Table D-4
Groundwater Screening Levels

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Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Back-ground	Groundwater Screening Levels					Primary Screening Level	
				MCL	CA-RSL[a]	CA-RSL (11/2010) Source	PHG[b]	PRGtw-CA[c]	Value	Source
PCB 195	52663-78-2	µg/L	--	--		--	--	--	--	--
PCB 206	40186-72-9	µg/L	--	--		--	--	--	--	--
PCB 28	7012-37-5	µg/L	--	--		--	--	--	--	--
PCB 44	41464-39-5	µg/L	--	--		--	--	--	--	--
PCB 52	35693-99-3	µg/L	--	--		--	--	--	--	--
PCB 66	32598-10-0	µg/L	--	--		--	--	--	--	--
PCB 77	32598-13-3	µg/L	--	--	0.0052	RSL	--	--	0.0052	RSL
PCB 8	34883-43-7	µg/L	--	--		--	--	--	--	--
PCB 81	70362-50-4	µg/L	--	--	0.0017	RSL	--	--	0.0017	RSL
Total PCBs	Total PCBs	µg/L	--	0.5		--	0.09	--	0.5	MCL
Pesticides										
4,4'-DDD	72-54-8	µg/L	--	--	0.28	RSL	--	--	0.28	RSL
4,4'-DDE	72-55-9	µg/L	--	--	0.2	RSL	--	--	0.2	RSL
4,4'-DDT	50-29-3	µg/L	--	--	0.2	RSL	--	--	0.2	RSL
Aldrin	309-00-2	µg/L	--	--	0.004	RSL	--	--	0.004	RSL
Alpha-BHC	319-84-6	µg/L	--	--	0.011	RSL	--	--	0.011	RSL
Alpha-Chlordane	5103-71-9	µg/L	--	--	0.19	RSL	0.03	--	0.03	PHG
Atrazine	1912-24-9	µg/L	--	3	0.29	RSL	0.15	--	0.001	NA
Beta-BHC	319-85-7	µg/L	--	--	0.037	RSL	--	--	0.037	RSL
Delta-BHC	319-86-8	µg/L	--	--		--	--	--	--	--
Dieldrin	60-57-1	µg/L	--	--	0.0042	RSL	--	--	0.0042	RSL
Endosulfan I	959-98-8	µg/L	--	--		--	--	--	--	--
Endosulfan II	33213-65-9	µg/L	--	--		--	--	--	--	--
Endosulfan Sulfate	1031-07-8	µg/L	--	--		--	--	--	--	--
Endrin	72-20-8	µg/L	--	2	11	RSL	1.8	--	2	MCL
Endrin Aldehyde	7421-93-4	µg/L	--	--		--	--	--	--	--
Gamma-Chlordane	5103-74-2	µg/L	--	--	0.19	RSL	0.03	--	0.03	PHG
HCH (gamma) Lindane	58-89-9	µg/L	--	0.2	0.061	RSL	0.032	--	0.2	MCL
Heptachlor	76-44-8	µg/L	--	0.01	0.015	RSL	0.008	--	0.01	MCL
Heptachlor Epoxide	1024-57-3	µg/L	--	0.01	0.0074	RSL	0.006	--	0.01	MCL
Methoxychlor	72-43-5	µg/L	--	30	180	RSL	0.09	--	30	MCL
Propiconazole	60207-90-1	µg/L	--	--	470	RSL	--	--	470	RSL
Toxaphene	8001-35-2	µg/L	--	3	0.061	RSL	0.03	--	3	MCL
Triphenyl phosphate	115-86-6	µg/L	--	--		--	--	--		--
Chlordane (technical)	57-74-9	µg/L	--	0.1	0.19	RSL	0.03	--	0.1	MCL
Canadian Pulp Method										
2,3,4,6-Tetrachlorophenol	58-90-2	µg/L	--	--	1100	RSL	--	--	1100	RSL
2,4,5-Trichlorophenol	95-95-4	µg/L	--	--	3700	RSL	--	--	3700	RSL

Table D-4
Groundwater Screening Levels

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Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Back-ground	Groundwater Screening Levels					Primary Screening Level	
				MCL	CA-RSL[a]	CA-RSL (11/2010) Source	PHG [b]	PRGtw-CA [c]	Value	Source
2,4,6-Tribromophenol	118-79-6	µg/L	--	--		--	--	--		--
2,4,6-Trichlorophenol	88-06-2	µg/L	--	--	0.96	HERD	--	0.9605	0.96	HERD
3,4,5-Trichlorophenol	609-19-8	µg/L	--	--		--	--	--		--
Pentachlorophenol	87-86-5	µg/L	--	1	0.17	RSL	0.3	--	1	MCL
Dioxins and Furans										
2,3,7,8 TCDD TEQ	EPADIOXTEQ(H)ND	pg/L	--	30		--	0.05	--	30	MCL
2,3,7,8-TCDD (Dioxin)	1746-01-6	pg/L	--	30	0.00000052	RSL	0.05	--	30	MCL
1,2,3,7,8-PeCDD	40321-76-4	pg/L	--	--		--	--	--	--	--
1,2,3,4,6,7,8-HpCDD	35822-46-9	pg/L	--	--		--	--	--	--	--
1,2,3,4,7,8-HxCDD	39227-28-6	pg/L	--	--	11	RSL	--	--	11	RSL
1,2,3,6,7,8-HxCDD	57653-85-7	pg/L	--	--	11	RSL	--	--	11	RSL
1,2,3,7,8,9-HxCDD	19408-74-3	pg/L	--	--	11	RSL	--	--	11	RSL
OCDD	3268-87-9	pg/L	--	--		--	--	--	--	--
2,3,7,8-TCDF	51207-31-9	pg/L	--	--		--	--	--	--	--
1,2,3,7,8-PeCDF	57117-41-6	pg/L	--	--		--	--	--	--	--
2,3,4,7,8-PeCDF	57117-31-4	pg/L	--	--		--	--	--	--	--
1,2,3,4,7,8-HxCDF	70648-26-9	pg/L	--	--		--	--	--	--	--
1,2,3,6,7,8-HxCDF	57117-44-9	pg/L	--	--		--	--	--	--	--
1,2,3,7,8,9-HxCDF	72918-21-9	pg/L	--	--		--	--	--	--	--
2,3,4,6,7,8-HxCDF	60851-34-5	pg/L	--	--		--	--	--	--	--
1,2,3,4,6,7,8-HpCDF	67562-39-4	pg/L	--	--		--	--	--	--	--
1,2,3,4,7,8,9-HpCDF	55673-89-7	pg/L	--	--		--	--	--	--	--
OCDF	39001-02-0	pg/L	--	--		--	--	--	--	--

Table D-4
Groundwater Screening Levels

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Back-ground	Groundwater Screening Levels					Primary Screening Level	
				MCL	CA-RSL[a]	CA-RSL (11/2010) Source	PHG [b]	PRGtw-CA [c]	Value	Source

Acronyms and Abbreviations:

-- = not available	not available
CalEPA	California Environmental Protection Agency
Cas. No.	Chemical Abstract Service number
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyl trichloroethane
DTSC	Department of Toxic Substances Control
ESL	environmental screening level
HERD	Human and Ecological Risk Division
HMW	high molecular weight
HpCDD	heptachlorodibenzo-p-dioxin
HpCDF	heptachlorodibenzofuran
HxCDD	hexachlorodibenzo-p-dioxin
HxCDF	hexachlorodibenzofuran
MCL	maximum contaminant level
MTBE	methyl tertiary-butyl ether
NA	not available
OCDD	octachlorodibenzo-p-dioxin
OCDF	octachlorodibenzofuran
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PeCDD	pentachlorodibenzo-p-dioxin
PeCDF	pentachlorodibenzofuran
pg/L	picograms per liter
PHG	public health goal
PRG	Preliminary Remediation Goals
RSL	regional screening level
SVOC	semivolatile organic compound
TCDD	tetrachlorodibenzo-p-dioxin
TEQ	toxic equivalent
tw	tap water
µg/L	micrograms per liter
USEPA	United States Environmental Protection Agency
VOC	volitile organic compound

Notes:

Screening levels were used in the following order of preference: More conservative of the CA or Federal Primary MCL > CA RSL > PHG > ALT.

MCLs shown are more conservative of federal and California MCLs.

a The more conservative of the November 2010 USEPA RSL update (USEPA, 2010) and HHRA Note 3 recommended values (DTSC, 2009).

b PHGs online at http://oehha.ca.gov/water/phg/index.html
c California-modified PRG (USEPA, 2004a)
d MCL for Total chromium
e Inorganic mercury
f 2004 U.S. EPA Region 9 'Cal-modified' PRGs for tap water. Recommended by HERD in Note 3 (DTSC, 2009).
g 2004 U.S. EPA Region 9 PRG, as recommended by HERD in Note 3 (DTSC, 2009). USEPA 2008 RSL is not available.
h 2004 U.S. EPA Region 9 PRGs for tap water (USEPA, 2004). Recommended by HERD in Note 3 (DTSC, 2009).
i CA-PRG. HERD recommends contact DTSC toxicologist if analyte present at your site (DTSC, 2009).
j Based on agriculture water quality objective.

References

DTSC. 2009. DTSC Recommended Methodology for Use of USEPA Screening Level (RSLs) in Human Health Risk Assessment Process at Department of Defense Sites and Facilities. HHRA Note 3. Available online at: http://www.dtsc.ca.gov/AssessingRisk/upload/HHRA-Note-3.pdf.

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Table D-5
Groundwater Water Quality Criteria

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	RWQCB WQOs [a]				Selected WQO	
			Chemical Obj - MCLs	Chemical Obj - Beneficial Use	Toxicity Obj	T&O Obj	Value	Source
Metals								
Aluminum (fume or dust)	7429-90-5	µg/L	200	1000	600	200	200	CA Secondary MCL
Antimony	7440-36-0	µg/L	6	6	20	--	6	CA Primary MCL
Arsenic	7440-38-2	µg/L	50	10	0.004	--	0.004	OEHHA PHG
Barium	7440-39-3	µg/L	1000	1000	2000	--	1000	CA Primary MCL
Beryllium	7440-41-7	µg/L	4	4	1	--	1	OEHHA PHG
Cadmium	7440-43-9	µg/L	5	5	0.04	--	0.04	OEHHA PHG
Chromium	7440-47-3	µg/L	50	50		--	50	CA Primary MCL
Chromium (hexavalent)	18540-29-9	µg/L					--	NA
Cobalt	7440-48-4	µg/L	--	50	--	--	50	Ag WQL
Copper	7440-50-8	µg/L	1000	200	300	1000	200	Ag WQL
Iron	7439-89-6	µg/L	300	5000	--	300	300	CA Secondary MCL
Lead	7439-92-1	µg/L	15	15	2	--	0.2	OEHHA PHG
Magnesium	7439-95-4	µg/L	NA	NA	NA	NA	NA	NA
Manganese	7439-96-5	µg/L	50	200	500	50	50	CA Secondary MCL
Mercury	7439-97-6	µg/L	2	2	1.2	--	1.2	OEHHA PHG
Molybdenum	7439-98-7	µg/L	--	10	35	--	10	Ag WQL
Nickel	7440-02-0	µg/L	100	100	12	--	12	OEHHA PHG
Selenium	7782-49-2	µg/L	50	20	35	--	10	NCBP WQO
Silver	7440-22-4	µg/L	100	--	35	100	35	IRIS RfD
Thallium	7440-28-0	µg/L	2	2	0.1	--	0.1	OEHHA PHG
Vanadium	7440-62-2	µg/L	--	100	50	--	50	CA Notification Level
Zinc	7440-66-6	µg/L	5000	2000	2100	5000	2000	Ag WQL
Volatile Organic Compounds (VOCs)								
1,1,1,2-Tetrachloroethane	630-20-6	µg/L	--	--	1	--	1	IRIS CRE
1,1,1-Trichloroethane	71-55-6	µg/L	200	200	1000	970	200	CA Primary MCL
1,1,2,2-Tetrachloroethane	79-34-5	µg/L	1	1	0.1	500	0.1	OEHHA PHG
1,1,2-Trichloroethane	79-00-5	µg/L	5	5	0.3	--	0.3	OEHHA PHG
1,1-Dichloroethane	75-34-3	µg/L	5	5	3	--	3	OEHHA PHG
1,1-Dichloroethene	75-35-4	µg/L	6	6	10	1500	6	CA Primary MCL
1,1-Dichloropropene	563-58-6	µg/L	--	--	--	--	--	NA
1,2,3-Trichlorobenzene	87-61-6	µg/L	--	--	--	--	--	NA
1,2,3-Trichloropropane	96-18-4	µg/L	--	--	0.005	--	0.005	CA Notification Level

Table D-5
Groundwater Water Quality Criteria

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	RWQCB WQOs [a]				Selected WQO	
			Chemical Obj - MCLs	Chemical Obj - Beneficial Use	Toxicity Obj	T&O Obj	Value	Source
1,2,4-Trichlorobenzene	120-82-1	µg/L	5	5	5	64	5	CA Primary MCL
1,2,4-Trimethylbenzene	95-63-6	µg/L	--	--	330	15	15	CVWQCB T&O
1,2-Dibromo-3-Chloropropane	96-12-8	µg/L	0.2	0.2	0.0017	10	0.0017	OEHHA PHG
1,2-Dichlorobenzene	95-50-1	µg/L	600	600	600	24	24	T&O Threshold
1,2-Dichloroethane	107-06-2	µg/L	0.5	0.5	0.4	7000	0.4	OEHHA PHG
1,2-Dichloropropane	78-87-5	µg/L	5	5	0.5	10	0.5	OEHHA PHG
1,3,5-Trimethylbenzene	108-67-8	µg/L	--	--	330	15	15	T&O Threshold
1,3-Butadiene	106-99-0	µg/L	--	--	0.01	1.4	0.01	Cal/EPA CPF
1,3-Dichlorobenzene	541-73-1	µg/L	--	--	600	--	600	CA Notification Level
1,3-Dichloropropane	142-28-9	µg/L	--	--	--	--	--	NA
1,4-Dichlorobenzene	106-46-7	µg/L	5	5	6	11	5	CA Primary MCL
2,2-Dichloropropane	594-20-7	µg/L	--	--	--	--	--	NA
2-Butanone	78-93-3	µg/L	--	--	4200	8400	4200	IRIS RfD
2-Chlorotoluene	95-49-8	µg/L	--	--	140	6.9	6.9	T&O Threshold
4-Chlorotoluene	106-43-4	µg/L	--	--	140	--	140	CA Notification Level
4-Methyl-2-Pentanone	108-10-1	µg/L	--	--	120	1300	120	CA Notification Level
Acetone	67-64-1	µg/L	--	--	6300	20000	6300	IRIS RfD
Benzene	71-43-2	µg/L	1	1	0.15	170	0.15	OEHHA PHG
Bromobenzene	108-86-1	µg/L	--	--	--	--	--	NA
Bromochloromethane	74-97-5	µg/L	--	--	90	34000	90	USEPA Non-cancer
Bromodichloromethane	75-27-4	µg/L	80	80	0.27	--	0.27	Cal/EPA CPF
Bromoform	75-25-2	µg/L	80	80	4	510	4	IRIS CRE
Bromomethane	74-83-9	µg/L	--	--	9.8	--	9.8	IRIS RfD
Carbon Disulfide	75-15-0	µg/L	--	--	160	0.39	0.39	T&O Threshold
Carbon Tetrachloride	56-23-5	µg/L	0.5	0.5	0.1	520	0.1	OEHHA PHG
Chlorinated Fluorocarbon (freon 113)	76-13-1	µg/L	1200	1200	4000	300000	1200	CA Primary MCL
Chlorobenzene	108-90-7	µg/L	70	70	200	20	20	US EPA NAWQC
Chloroethane	75-00-3	µg/L	--	--	75	16	16	T&O Threshold
Chloroform	67-66-3	µg/L	80	80	1.1	2400	1.1	Cal/EPA CPF
Chloromethane	74-87-3	µg/L	--	--	3	--	3	USEPA Non-cancer
cis-1,2-Dichloroethene	156-59-2	µg/L	6	6	100	--	6	CA Primary MCL
cis-1,3-Dichloropropene	10061-01-5	µg/L	0.5	0.5	0.2	--	0.2	OEHHA PHG
Dibromochloromethane	124-48-1	µg/L	80	80	0.37	--	0.37	Cal/EPA CPF

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Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	RWQCB WQOs [a]				Selected WQO	
			Chemical Obj - MCLs	Chemical Obj - Beneficial Use	Toxicity Obj	T&O Obj	Value	Source
Dibromomethane	74-95-3	µg/L	NA	NA	NA	NA	NA	NA
Dichlorodifluoromethane	75-71-8	µg/L	--	--	1000	--	1000	CA Notification Level
Ethanol	64-17-5	µg/L	--	--	--	760000	760000	T&O Threshold
Ethylbenzene	100-41-4	µg/L	300	300	300	29	3.2	NCRWQCB
Ethylene Dibromide	106-93-4	µg/L	0.05	0.05	0.01	--	0.01	OEHHA PHG
Hexachlorobutadiene	87-68-3	µg/L	--	--	0.5	--	0.5	IRIS CRE
Isopropyl alcohol (manufacturing-strong acid	67-63-0	µg/L	--	--	--	160000	160000	T&O Threshold
Isopropylbenzene	98-82-8	µg/L	--	--	770	0.8	0.8	T&O Threshold
m,p-Xylenes	1330-20-7	µg/L	1750	1750	1800	17	17	T&O Threshold
Methyl n-Butyl Ketone	591-78-6	µg/L	--	--	--	250	250	T&O Threshold
Methylene Chloride	75-09-2	µg/L	5	5	4	9100	4	OEHHA PHG
MTBE	1634-04-4	µg/L	5	13	13	5	5	CA Secondary MCL
n-Butylbenzene	104-51-8	µg/L	--	--	260	--	260	CA Notification Level
n-Propylbenzene	103-65-1	µg/L	--	--	260	--	260	CA Notification Level
o-xylene	95-47-6	µg/L	1750	1750	1800	17	17	T&O Threshold
Para-Isopropyl Toluene	99-87-6	µg/L	NA	NA	NA	NA	NA	NA
sec-Butylbenzene	135-98-8	µg/L	--	--	260	--	260	CA Notification Level
Styrene	100-42-5	µg/L	100	100	140	11	11	T&O Threshold
Tert-Butylbenzene	98-06-6	µg/L	--	--	260	--	260	CA Notification Level
Tetrachloroethene	127-18-4	µg/L	5	5	0.06	170	0.06	OEHHA PHG
Toluene	108-88-3	µg/L	150	150	150	42	42	T&O Threshold
trans-1,2-Dichloroethene	156-60-5	µg/L	10	10	60	260	10	CA Primary MCL
trans-1,3-Dichloropropene	10061-02-6	µg/L	0.5	0.5	0.2	--	0.2	OEHHA PHG
Trichloroethene	79-01-6	µg/L	5	5	0.8	310	1.7	OEHHA PHG
Trichlorofluoromethane (freon 11)	75-69-4	µg/L	150	150	700	--	150	CA Primary MCL
Vinyl Acetate	108-05-4	µg/L	--	--	--	88	88	T&O Threshold
Vinyl Chloride	75-01-4	µg/L	0.5	0.5	0.05	3400	0.05	OEHHA PHG
Xylenes, Total	1330-20-7	µg/L	1750	1750	1800	17	17	T&O Threshold
Polycyclic Aromatic Hydrocarbons (PAHs)								
Acenaphthene	83-32-9	µg/L	--	--	420	20	20	US EPA NAWQC
Acenaphthylene	208-96-8	µg/L	--	--	--	--	--	NA
Anthracene	120-12-7	µg/L	--	--	2100	--	2100	IRIS RfD
Benzo(a)anthracene	56-55-3	µg/L	--	--	0.04	--	0.04	Cal/EPA CPF

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			RWQCB WQOs [a]				Selected WQO	
Constituent/Analytical Group	CAS No.	Units	Chemical Obj - MCLs	Chemical Obj - Beneficial Use	Toxicity Obj	T&O Obj	Value	Source
Benzo(a)pyrene	50-32-8	µg/L	0.2	0.2	0.007	--	0.007	OEHHA PHG
Benzo(b)fluoranthene	205-99-2	µg/L	--	--	0.04	--	0.04	Cal/EPA CPF
Benzo(g,h,i)perylene	191-24-2	µg/L	--	--	--	--	--	NA
Benzo(k)fluoranthene	207-08-9	µg/L	--	--	0.04	--	0.04	Cal/EPA CPF
Chrysene	218-01-9	µg/L	--	--	0.4	--	0.4	Cal/EPA CPF
Dibenz(a,h)anthracene	53-70-3	µg/L	--	--	0.0085	--	0.0085	Cal/EPA CPF
Fluoranthene	206-44-0	µg/L	--	--	280	--	280	IRIS RfD
Fluorene	86-73-7	µg/L	--	--	280	--	280	IRIS RfD
Indeno(1,2,3-cd)Pyrene	193-39-5	µg/L	--	--	0.04	--	0.04	Cal/EPA CPF
Naphthalene	91-20-3	µg/L	--	--	17	21	17	CA Notification Level
Phenanthrene	85-01-8	µg/L	--	--	--	--	--	NA
Pyrene	129-00-0	µg/L	--	--	210	--	210	IRIS RfD
B(a)P TEQ	--	µg/L	0.2	0.2	0.007	--	0.007	OEHHA PHG
Semivolatile Organic Compounds (SVOCs)								
2,4-Dichlorophenol	120-83-2	µg/L	--	--	21	0.3	0.3	US EPA NAWQC
2,4-Dimethylphenol	105-67-9	µg/L	--	--	100	400	100	CA Notification Level
2,4-Dinitrophenol	51-28-5	µg/L	--	--	14	--	14	IRIS RfD
2,4-Dinitrotoluene	121-14-2	µg/L	--	--	0.11	--	0.11	Cal/EPA CPF
2,6-Dinitrotoluene	606-20-2	µg/L	--	--	0.05	--	0.05	IRIS CRE
2-Chloronaphthalene	91-58-7	µg/L	--	--	560	--	560	IRIS RfD
2-Chlorophenol	95-57-8	µg/L	--	--	35	0.1	0.1	US EPA NAWQC
2-Methylnaphthalene	91-57-6	µg/L	--	--	28	--	28	IRIS RfD
2-Methylphenol	95-48-7	µg/L	--	--	35	--	35	IRIS RfD
2-Nitroaniline	88-74-4	µg/L	NA	NA	NA	NA	NA	NA
2-Nitrophenol	88-75-5	µg/L	--	--	290	--	290	NAS DWHA
3,3'-Dichlorobenzidine	91-94-1	µg/L	--	--	0.029	--	0.029	Cal/EPA CPF
3-Nitroaniline	99-09-2	µg/L	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-Methylphenol	534-52-1	µg/L	--	--	110	--	110	NAS DWHA
4-Bromophenyl-phenylether	101-55-3	µg/L	--	--	--	--	--	NA
4-Chloro-3-Methylphenol	59-50-7	µg/L	--	--	--	3000	3000	US EPA NAWQC
4-Chloroaniline	106-47-8	µg/L	--	--	28	--	28	IRIS RfD
4-Chlorophenyl-phenylether	7005-72-3	µg/L	NA	NA	NA	NA	NA	NA
4-Methylphenol	106-44-5	µg/L	--	--	--	--	--	NA

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Constituent/Analytical Group	CAS No.	Units	RWQCB WQOs [a]				Selected WQO	
			Chemical Obj - MCLs	Chemical Obj - Beneficial Use	Toxicity Obj	T&O Obj	Value	Source
4-Nitroaniline	100-01-6	µg/L	NA	NA	NA	NA	NA	NA
4-Nitrophenol	100-02-7	µg/L	--	--	60	--	60	USEPA Non-cancer
Azobenzene	103-33-3	µg/L	--	--	0.32	--	0.32	Cal/EPA CPF
Benzoic acid	65-85-0	µg/L	--	--	28000	--	28000	IRIS RfD
Benzyl Alcohol	100-51-6	µg/L	NA	NA	NA	NA	NA	NA
bis(2-Chloroethoxy)Methane	111-91-1	µg/L	--	--	--	--	--	NA
bis(2-Chloroethyl)Ether	111-44-4	µg/L	--	--	0.014	360	0.014	Cal/EPA CPF
bis(2-Chloroisopropyl)ether	39638-32-9	µg/L	--	--	280	--	280	IRIS RfD
bis(2-Ethylhexyl)Phthalate	117-81-7	µg/L	4	4	12	--	4	CA Primary MCL
Butyl Benzyl Phthalate	85-68-7	µg/L	--	--	140	--	140	IRIS RfD
Dibenzofuran	132-64-9	µg/L	NA	NA	NA	NA	NA	NA
Diethylphthalate	84-66-2	µg/L	--	--	5600	--	5600	IRIS RfD
Dimethylphthalate	131-11-3	µg/L	--	--	--	--	--	NA
Di-n-butylphthalate	84-74-2	µg/L	--	--	700	--	700	IRIS RfD
Di-n-octylphthalate	117-84-0	µg/L	--	--	--	--	--	NA
Hexachlorobenzene	118-74-1	µg/L	1	1	0.03	--	0.03	OEHHA PHG
Hexachlorocyclopentadiene	77-47-4	µg/L	50	50	50	1	1	US EPA NAWQC
Hexachloroethane	67-72-1	µg/L	--	--	0.9	10	0.9	Cal/EPA CPF
Isophorone	78-59-1	µg/L	--	--	40	5400	40	IRIS CRE
Nitrobenzene	98-95-3	µg/L	--	--	3.5	30	3.5	IRIS RfD
N-Nitrosodimethylamine	62-75-9	µg/L	--	--	0.003	--	0.003	OEHHA PHG
N-Nitroso-di-n-propylamine	621-64-7	µg/L	--	--	0.005	--	0.005	Cal/EPA CPF
N-Nitrosodiphenylamine	86-30-6	µg/L	--	--	3.9	--	3.9	Cal/EPA CPF
Phenol	108-95-2	µg/L	--	--	4200	300	300	US EPA NAWQC
Resorcinol	108-46-3	µg/L	--	--	500	--	500	NAS DWHA
Polychlorinated Biphenyls (PCBs)								
Arochlor-1016	12674-11-2	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
Arochlor-1221	11104-28-2	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
Arochlor-1232	11141-16-5	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
Arochlor-1242	53469-21-9	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
Arochlor-1248	12672-29-6	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
Arochlor-1254	11097-69-1	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
Arochlor-1260	11096-82-5	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG

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Constituent/Analytical Group	CAS No.	Units	RWQCB WQOs [a]				Selected WQO	
			Chemical Obj - MCLs	Chemical Obj - Beneficial Use	Toxicity Obj	T&O Obj	Value	Source
Aroclor-1268	11100-14-4	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 101	37680-73-2	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 105	32598-14-4	µg/L	--	--	0.0027	--	0.0027	Cal/EPA CPF
PCB 114	74472-37-0	µg/L	--	--	0.00054	--	0.00054	Cal/EPA CPF
PCB 118	31508-00-6	µg/L	--	--	0.0027	--	0.0027	Cal/EPA CPF
PCB 123	65510-44-3	µg/L	--	--	0.0027	--	0.0027	Cal/EPA CPF
PCB 126	57465-28-8	µg/L	--	--	0.0000027	--	0.0000027	Cal/EPA CPF
PCB 128	38380-07-3	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 138	35065-28-2	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 153	35065-27-1	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 156	38380-08-4	µg/L	--	--	0.00054	--	0.00054	Cal/EPA CPF
PCB 157	69782-90-7	µg/L	--	--	0.00054	--	0.00054	Cal/EPA CPF
PCB 167	52663-72-6	µg/L	--	--	0.027	--	0.027	Cal/EPA CPF
PCB 169	32774-16-6	µg/L	--	--	0.000027	--	0.000027	Cal/EPA CPF
PCB 170	35065-30-6	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 18	37680-65-2	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 180	35065-29-3	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 187	52663-68-0	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 189	39635-31-9	µg/L	--	--	0.0027	--	0.0027	Cal/EPA CPF
PCB 195	52663-78-2	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 206	40186-72-9	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 28	7012-37-5	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 44	41464-39-5	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 52	35693-99-3	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 66	32598-10-0	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 77	32598-13-3	µg/L	--	--	0.0027	--	0.0027	Cal/EPA CPF
PCB 8	34883-43-7	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
PCB 81	70362-50-4	µg/L	--	--	0.0027	--	0.0027	Cal/EPA CPF
Total PCBs	Total PCBs	µg/L	0.5	0.5	0.09	--	0.09	OEHHA PHG
Pesticides								
4,4'-DDD	72-54-8	µg/L	--	--	0.15	--	0.15	Cal/EPA CPF
4,4'-DDE	72-55-9	µg/L	--	--	0.1	--	0.1	Cal/EPA CPF
4,4'-DDT	50-29-3	µg/L	--	--	0.1	--	0.1	Cal/EPA CPF

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Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	RWQCB WQOs [a]				Selected WQO	
			Chemical Obj - MCLs	Chemical Obj - Beneficial Use	Toxicity Obj	T&O Obj	Value	Source
Aldrin	309-00-2	µg/L	--	--	0.0021	--	0.0021	Cal/EPA CPF
Alpha-BHC	319-84-6	µg/L	--	--	0.013	--	0.013	Cal/EPA CPF
Alpha-Chlordane	5103-71-9	µg/L	0.1	0.1	0.03	--	0.03	OEHHA PHG
Atrazine	1912-24-9	µg/L	1	1	0.15	--	0.15	OEHHA PHG
Beta-BHC	319-85-7	µg/L	--	--	0.023	--	0.023	Cal/EPA CPF
Delta-BHC	319-86-8	µg/L	--	--	500	--	500	NAS DWHA
Dieldrin	60-57-1	µg/L	--	--	0.0022	--	0.0022	Cal/EPA CPF
Endosulfan I	959-98-8	µg/L	--	--	42	--	42	IRIS RfD
Endosulfan II	33213-65-9	µg/L	--	--	42	--	42	IRIS RfD
Endosulfan Sulfate	1031-07-8	µg/L	--	--	--	--	--	NA
Endrin	72-20-8	µg/L	2	2	1.8	--	0.2	NCBP WQO
Endrin Aldehyde	7421-93-4	µg/L	--	--	--	--	--	NA
Gamma-Chlordane	5103-74-2	µg/L	0.1	0.1	0.03	--	0.03	OEHHA PHG
HCH (gamma) Lindane	58-89-9	µg/L	0.2	0.2	0.032	--	0.032	OEHHA PHG
Heptachlor	76-44-8	µg/L	0.01	0.01	0.008	--	0.008	OEHHA PHG
Heptachlor Epoxide	1024-57-3	µg/L	0.01	0.01	0.006	--	0.006	OEHHA PHG
Methoxychlor	72-43-5	µg/L	30	30	30	4700	30	CA Primary MCL
Propiconazole	60207-90-1	µg/L	--	--	91	--	91	IRIS RfD
Toxaphene	8001-35-2	µg/L	3	3	0.03	140	0.03	OEHHA PHG
Triphenyl phosphate	115-86-6	µg/L	NA	NA	NA	NA	NA	NA
Chlordane (technical)	57-74-9	µg/L	0.1	0.1	0.03	--	0.03	OEHHA PHG
Canadian Pulp Method								
2,3,4,6-Tetrachlorophenol	58-90-2	µg/L	--	--	210	1	1	US EPA NAWQC
2,4,5-Trichlorophenol	95-95-4	µg/L	--	--	700	1	1	US EPA NAWQC
2,4,6-Tribromophenol	118-79-6	µg/L	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	88-06-2	µg/L	--	--	0.5	2	0.5	Cal/EPA CPF
3,4,5-Trichlorophenol	609-19-8	µg/L	NA	NA	NA	NA	NA	NA
Pentachlorophenol	87-86-5	µg/L	1	1	0.4	30	0.3	OEHHA PHG
Dioxins and Furans								
2,3,7,8 TCDD TEQ	EPADIOXTEQ(H)ND	pg/L	30	30	0.05	--	0.05	Cal/EPA CPF
2,3,7,8-TCDD (Dioxin)	1746-01-6	pg/L	30	30	0.05	--	0.05	Cal/EPA CPF
1,2,3,7,8-PeCDD	40321-76-4	pg/L	--	--	0.27	--	0.27	Cal/EPA CPF
1,2,3,4,6,7,8-HpCDD	35822-46-9	pg/L	--	--	27	--	27	Cal/EPA CPF

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			RWQCB WQOs [a]				Selected WQO	
Constituent/Analytical Group	**CAS No.**	**Units**	**Chemical Obj - MCLs**	**Chemical Obj - Beneficial Use**	**Toxicity Obj**	**T&O Obj**	**Value**	**Source**
1,2,3,4,7,8-HxCDD	39227-28-6	pg/L	--	--	2.7	--	2.7	Cal/EPA CPF
1,2,3,6,7,8-HxCDD	57653-85-7	pg/L	--	--	2.7	--	2.7	Cal/EPA CPF
1,2,3,7,8,9-HxCDD	19408-74-3	pg/L	--	--	11	--	11	Cal/EPA CPF
OCDD	3268-87-9	pg/L	--	--	2700	--	2700	Cal/EPA CPF
2,3,7,8-TCDF	51207-31-9	pg/L	--	--	2.7	--	2.7	Cal/EPA CPF
1,2,3,7,8-PeCDF	57117-41-6	pg/L	--	--	5.4	--	5.4	Cal/EPA CPF
2,3,4,7,8-PeCDF	57117-31-4	pg/L	--	--	0.54	--	0.54	Cal/EPA CPF
1,2,3,4,7,8-HxCDF	70648-26-9	pg/L	--	--	2.7	--	2.7	Cal/EPA CPF
1,2,3,6,7,8-HxCDF	57117-44-9	pg/L	--	--	2.7	--	2.7	Cal/EPA CPF
1,2,3,7,8,9-HxCDF	72918-21-9	pg/L	--	--	2.7	--	2.7	Cal/EPA CPF
2,3,4,6,7,8-HxCDF	60851-34-5	pg/L	--	--	2.7	--	2.7	Cal/EPA CPF
1,2,3,4,6,7,8-HpCDF	67562-39-4	pg/L	--	--	27	--	27	Cal/EPA CPF
1,2,3,4,7,8,9-HpCDF	55673-89-7	pg/L	--	--	27	--	27	Cal/EPA CPF
OCDF	39001-02-0	pg/L	--	--	2700	--	2700	Cal/EPA CPF

Acronyms and Abbreviations:

Ag WQL	Agricultural Water Quality Limits
CA Notification Level	California State Notification Level (formerly Action Level)
CA Primary MCL	California Department of Public Health Primary MCL
CA Secondary MCL	California Department of Public Health Secondary MCL
Cal/EPA	California Environmental Protection Agency
Cal/EPA CPF	One-in-a-Million Incremental Cancer Risk Estimates for Drinking Water, Cal/EPA Cancer Potency Factor
Cas. No.	Chemical Abstract Service number
CDPH	California Department of Public Health
CVWQCB T&O	CVRWQCB (2004) TPH water quality objectives for taste and odor
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyl trichloroethane
IRIS CRE	USEPA Integrated Risk Information System (IRIS) One-in-a-million Incremental Cancer Risk Estimate For Drinking Water
IRIS RfD	USEPA Integrated Risk Information System (IRIS) Reference Dose as Drinking Water Level
HpCDD	heptachlorodibenzo-p-dioxin
HpCDF	heptachlorodibenzofuran

Table D-5
Groundwater Water Quality Criteria

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	RWQCB WQOs [a]				Selected WQO	
			Chemical Obj - MCLs	Chemical Obj - Beneficial Use	Toxicity Obj	T&O Obj	Value	Source
Hx-CDD	hexachlorodibenzo-p-dioxin							
HxCDF	hexachlorodibenzofuran							
MCL	Maximum Contaminant Level							
MTBE	methyl tertiary-butyl ether							
Obj	Objective							
--	Not available							
NA	Not available							
NAS DWHA	National Academy of Sciences Drinking Water Health Advisories or Suggested SNARLs for toxicity other than cancer risk							
NCBP WQO	North Coast Basin Plan Water Quality Objective							
NCRWQCB	North Coast Regional Water Quality Control Board							
Obj	objective							
OCDD	octachlorodibenzo-p-dioxin							
OCDF	octachlorodibenzofuran							
OEHHA PHG	Office of Environmental Health and Safety Public Health Goal							
PAH	polycyclic aromatic hydrocarbon							
PCB	polychlorinated biphenyl							
PEC	probable effects concentration							
PeCDD	pentachlorodibenzo-p-dioxin							
PECDF	pentachlorodibenzofuran							
pg/L	picograms per liter							
PHG	public health goal							
SVOC	semivolatile organic compund							
TCDD	tetrachlorodibenzo-p-dioxin							
TEQ	toxic equivalent							
T&O	taste and odor							
µg/L	micrograms per liter							
USEPA NAWQC	USEPA National Ambient Water Quality Criteria							
USEPA Non-cancer Limit	USEPA Drinking Water Health Advisories or Suggested SNARLs for toxicity other than cancer risk							
USEPA	United States Environmental Protection Agency							
WQCP	Water Quality Control Plan							
VOC	volitile organic compound							

Table D-5
Groundwater Water Quality Criteria

Draft Remedial Investigation Report Operable Unit E
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Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	RWQCB WQOs [a]				Selected WQO	
			Chemical Obj - MCLs	Chemical Obj - Beneficial Use	Toxicity Obj	T&O Obj	Value	Source

Notes:

a. Developed following the hierarchy outlined in **A Compilation of Water Quality Goals** (CalEPA, 2011), which includes:

- selecting a chemical constituent's objective as the lowest value between the state and federal MCLs, WQCP numerical objectives, and agricultural use limits
- selecting a toxicity objective according to a listed hierarchy of preferred values
- selecting a taste and odor objective according to a listed hierarchy of preferred values
- selecting the lowest limit for the three values selected as described above.

Table D-5
Groundwater Water Quality Criteria

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			RWQCB WQOs [a]				Selected WQO	
Constituent/Analytical Group	CAS No.	Units	Chemical Obj - MCLs	Chemical Obj - Beneficial Use	Toxicity Obj	T&O Obj	Value	Source

References

CalEPA. 2011. A Compilation of Water Quality Goals, 16th Edition. Available online at http://www.waterboards.ca.gov/water_issues/water_quality_standards_limits/water_quality_goals/index.shtml. California Environmental Protection Agency - State Water Resources Control Board. April.

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Group	CAS No.	Units	Surface Water Screening Levels					
			Primary Screening Level [a]		Ocean Plan Screening Criteria[b]			
			Value	Source	Protection of Human Health	Protection of Marine Aquatic Life	Selected Value	
	7440-36-0	µg/L	30	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	1200	--	1200	Ca
	7440-38-2	µg/L	150	CA Toxics Rule (40 CFR Part 131)	--	8	8	
	7440-39-3	µg/L	--	--	--	--	--	
	7440-41-7	µg/L	0.66	Suter and Tsao (1996)	0.033	--	0.033	Ca
	7440-43-9	µg/L	2.2	CA Toxics Rule (40 CFR Part 131)	--	1	1	
	7440-47-3	µg/L	--	--	190000	--	190000	Ca
	18540-29-9	µg/L	--	--	--	2	2	Ca
	7440-48-4	µg/L	23	Suter and Tsao (1996)	--	--	--	
	7440-50-8	µg/L	9	CA Toxics Rule (40 CFR Part 131)	--	3	3	Ca
	7439-89-6	µg/L	--	--	--	--	--	
	7439-92-1	µg/L	2.5	CA Toxics Rule (40 CFR Part 131)	--	2	2	Ca
	7439-96-5	µg/L	--	--	--	--	--	
	7439-97-6	µg/L	--	--	--	0.04	0.04	Ca
	7439-98-7	µg/L	370	Suter and Tsao (1996)	--	--	--	
	7440-02-0	µg/L	52	CA Toxics Rule (40 CFR Part 131)	--	5	5	Ca
	7782-49-2	µg/L	5	CA Toxics Rule (40 CFR Part 131)	--	15	15	Ca
	7440-22-4	µg/L	0.36	Suter and Tsao (1996)	--	0.7	0.7	Ca
	7440-28-0	µg/L	12	Suter and Tsao (1996)	2	--	2	Ca
	7440-62-2	µg/L	20	Suter and Tsao (1996)	--	--	--	
	7440-66-6	µg/L	120	CA Toxics Rule (40 CFR Part 131)	--	20	20	Ca
pounds (VOCs)								
ne	630-20-6	µg/L	--	--	--	--	--	
	71-55-6	µg/L	11	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	540000	--	540000	Ca
ne	79-34-5	µg/L	2400	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	2.3	--	2.3	Ca
	79-00-5	µg/L	1200	Suter and Tsao (1996)	9.4	--	9.4	Ca
	75-34-3	µg/L	47	Suter and Tsao (1996)	--	--	--	
	75-35-4	µg/L	25	Suter and Tsao (1996)	0.9	--	0.9	Ca
	563-58-6	µg/L	--	--	--	--	--	
	87-61-6	µg/L	--	--	--	--	--	
	96-18-4	µg/L	--	--	--	--	--	
	120-82-1	µg/L	110	Suter and Tsao (1996)	--	--	--	

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Group	CAS No.	Units	Surface Water Screening Levels					
			Primary Screening Level [a]		Ocean Plan Screening Criteria[b]			
			Value	Source	Protection of Human Health	Protection of Marine Aquatic Life	Selected Value	
	95-50-1	µg/L	14	Suter and Tsao (1996)	5100	--	5100	Ca
	107-06-2	µg/L	590	Suter and Tsao (1996)	28	--	28	Ca
	78-87-5	µg/L	360	USEPA Region 5 ESLs (2003)	--	--	--	
	108-67-8	µg/L	--	--	--	--	--	
	106-99-0	µg/L	--	--	--	--	--	
	541-73-1	µg/L	71	Suter and Tsao (1996)	5100	--	5100	Ca
	142-28-9	µg/L	--	--	--	--	--	
	106-46-7	µg/L	15	Suter and Tsao (1996)	18	--	18	Ca
	594-20-7	µg/L	--	--	--	--	--	
	78-93-3	µg/L	14000	Suter and Tsao (1996)	--	--	--	
	95-49-8	µg/L	--	--	--	--	--	
	106-43-4	µg/L	--	--	--	--	--	
	108-10-1	µg/L	170	Suter and Tsao (1996)	--	--	--	
	67-64-1	µg/L	1500	Suter and Tsao (1996)	--	--	--	
	71-43-2	µg/L	130	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	5.9	--	5.9	Ca
	108-86-1	µg/L	--	--	--	--	--	
	74-97-5	µg/L	--	--	--	--	--	
	75-27-4	µg/L	--	--	6.2	--	6.2	Ca
	75-25-2	µg/L	230	USEPA Region 5 ESLs (2003d)	130	--	130	Ca
	74-83-9	µg/L	--	--	130	--	130	Ca
	75-15-0	µg/L	0.92	Suter and Tsao (1996)	--	--	--	
	56-23-5	µg/L	9.8	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	0.9	--	0.9	Ca
on (freon 113)	76-13-1	µg/L	--	--	--	--	--	
	108-90-7	µg/L	64	Suter and Tsao (1996)	570	--	570	Ca
	75-00-3	µg/L	--	--	--	--	--	
	67-66-3	µg/L	28	Suter and Tsao (1996)	130	--	130	Ca
	74-87-3	µg/L	--	--	130	--	130	Ca
	156-59-2	µg/L	970	USEPA Region 5 ESLs (2003)	--	--	--	
	10061-01-5	µg/L	--	--	--	--	--	
	124-48-1	µg/L	--	--	8.6	--	8.6	Ca
	74-95-3	µg/L	--	--	--	--	--	
e	75-71-8	µg/L	--	--	--	--	--	
	64-17-5	µg/L	--	--	--	--	--	

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Group	CAS No.	Units	Surface Water Screening Levels					
			Primary Screening Level [a]		Ocean Plan Screening Criteria[b]			
			Value	Source	Protection of Human Health	Protection of Marine Aquatic Life	Selected Value	
	87-68-3	µg/L	0.053	USEPA Region 5 ESLs (2003)	14	--	14	Ca
	67-63-0	µg/L	--	--	--	--	--	
	98-82-8	µg/L	--	--	--	--	--	
	1330-20-7	µg/L	13	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	--	--	--	
	591-78-6	µg/L	--	--	--	--	--	
	75-09-2	µg/L	2200	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	450	--	450	Ca
	1634-04-4	µg/L	--	--	--	--	--	
	104-51-8	µg/L	--	--	--	--	--	
	103-65-1	µg/L	--	--	--	--	--	
	95-47-6	µg/L	--	--	--	--	--	
	99-87-6	µg/L	--	--	--	--	--	
	135-98-8	µg/L	--	--	--	--	--	
	100-42-5	µg/L	32	USEPA Region 5 ESLs (2003)	--	--	--	
	98-06-6	µg/L	--	--	--	--	--	
	127-18-4	µg/L	--	--	2	--	2	Ca
	108-88-3	µg/L	9.8	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	85000	--	85000	Ca
e	156-60-5	µg/L	970	USEPA Region 5 ESLs (2003)	--	--	--	
ne	10061-02-6	µg/L	--	--	--	--	--	
	79-01-6	µg/L	47	USEPA Region 5 ESLs (2003)	27	--	27	Ca
(freon 11)	75-69-4	µg/L	--	--	--	--	--	
	108-05-4	µg/L	--	--	--	--	--	
	75-01-4	µg/L	930	USEPA Region 5 ESLs (2003)	36	--	36	Ca
	1330-20-7	µg/L	13	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	--	--	--	
ydrocarbons (PAHs)								
	83-32-9	µg/L	38	USEPA Region 5 ESLs (2003d)	--	--	--	
	208-96-8	µg/L	--	--	--	--	--	
	120-12-7	µg/L	0.73	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	--	--	--	
	56-55-3	µg/L	0.027	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	--	--	--	
	50-32-8	µg/L	0.014	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	--	--	--	
	205-99-2	µg/L	0.014	B(a)P surrogate for all HMW PAHs	--	--	--	
	191-24-2	µg/L	0.014	B(a)P surrogate for all HMW PAHs	--	--	--	
	207-08-9	µg/L	0.014	B(a)P surrogate for all HMW PAHs	--	--	--	

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Group	CAS No.	Units	Surface Water Screening Levels: Primary Screening Level [a]: Value	Source	Ocean Plan Screening Criteria[b]: Protection of Human Health	Protection of Marine Aquatic Life	Selected Value	
	206-44-0	µg/L	1.9	USEPA Region 5 ESLs (2003)	15	--	15	Ca
	86-73-7	µg/L	3.9	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	--	--	--	
	193-39-5	µg/L	0.014	B(a)P surrogate for all HMW PAHs	--	--	--	
	91-20-3	µg/L	12	Suter and Tsao (1996)	--	--	--	
	85-01-8	µg/L	6.3	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	--	--	--	
	129-00-0	µg/L	0.014	B(a)P surrogate for all HMW PAHs	--	--	--	
	--	µg/L	0.014	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	--	--	--	
Compounds (SVOCs)								
	120-83-2	µg/L	11	USEPA Region 5 ESLs (2003)		1	1	
	105-67-9	µg/L	--	--		30	30	
	51-28-5	µg/L	19	USEPA Region 5 ESLs (2003)	4	30	4	Ca
	121-14-2	µg/L	44	USEPA Region 5 ESLs (2003)	2.6	--	2.6	Ca
	606-20-2	µg/L	81	USEPA Region 5 ESLs (2003)	--	--	--	
	91-58-7	µg/L	0.396	USEPA Region 5 ESLs (2003)	--	--	--	
	95-57-8	µg/L	24	USEPA Region 5 ESLs (2003)		1	1	
	91-57-6	µg/L	--	--	--	--	--	
	95-48-7	µg/L	13	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	--	--	--	
	88-74-4	µg/L	--	--	--	--	--	
	88-75-5	µg/L	--	--		30	30	
	91-94-1	µg/L	4.5	USEPA Region 5 ESLs (2003)	0.0081	--	0.0081	Ca
	99-09-2	µg/L	--	--	--	--	--	
nol	534-52-1	µg/L	23	USEPA Region 5 ESLs (2003)	220	30	30	Ca
ther	101-55-3	µg/L	1.5	Suter and Tsao (1996)	--	--	--	
ol	59-50-7	µg/L	--	--		1	1	
	106-47-8	µg/L	232	USEPA Region 5 ESLs (2003)	--	--	--	
ther	7005-72-3	µg/L	--	--	--	--	--	
	106-44-5	µg/L	--	--	--	--	--	
	100-01-6	µg/L	--	--	--	--	--	
	100-02-7	µg/L	300	Suter and Tsao (1996)		30	30	
	103-33-3	µg/L	--	--	--	--	--	
	65-85-0	µg/L	42	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	--	--	--	

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Group	CAS No.	Units	Surface Water Screening Levels					
			Primary Screening Level [a]		Ocean Plan Screening Criteria[b]			
			Value	Source	Protection of Human Health	Protection of Marine Aquatic Life	Selected Value	
hane	111-91-1	µg/L	--	--	4.4	--	4.4	Ca
	111-44-4	µg/L	19000	USEPA Region 5 ESLs (2003)	0.045	--	0.045	Ca
her	39638-32-9	µg/L	--	--	1200	--	1200	Ca
te	117-81-7	µg/L	360	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	3.5	--	3.5	Ca
	85-68-7	µg/L	19	Suter and Tsao (1996)	--	--	--	
	132-64-9	µg/L	3.7	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	--	--	--	
	84-66-2	µg/L	210	Suter and Tsao (1996)	33000	--	33000	Ca
	131-11-3	µg/L	--	--	820000	--	820000	Ca
	84-74-2	µg/L	9.7	USEPA Region 5 ESLs (2003)	3500	--	3500	Ca
	117-84-0	µg/L	--	--	--	--	--	
	118-74-1	µg/L	3.68	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	0.00021	--	0.00021	Ca
ene	77-47-4	µg/L	77	USEPA Region 5 ESLs (2003)	58	--	58	
	67-72-1	µg/L	12	Suter and Tsao (1996)	2.5	--	2.5	Ca
	78-59-1	µg/L	920	USEPA Region 5 ESLs (2003)	730	--	730	Ca
	98-95-3	µg/L	220	USEPA Region 5 ESLs (2003)	4.9	--	4.9	Ca
e	62-75-9	µg/L	--	--	7.3	--	7.3	Ca
ine	621-64-7	µg/L	--	--	0.38	--	0.38	Ca
e	86-30-6	µg/L	210	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	2.5	--	2.5	Ca
	108-95-2	µg/L	180	USEPA Region 5 ESLs (2003)	--	1	1	Ca
	108-46-3	µg/L	--	--	--	30	30	Ca
nyls (PCBs)								
	12674-11-2	µg/L	--	--	--	--	--	
	11104-28-2	µg/L	--	--	--	--	--	
	11141-16-5	µg/L	--	--	--	--	--	
	53469-21-9	µg/L	--	--	--	--	--	
	12672-29-6	µg/L	--	--	--	--	--	
	11097-69-1	µg/L	--	--	--	--	--	
	11096-82-5	µg/L	--	--	--	--	--	
	11100-14-4	µg/L	--	--	--	--	--	
	37680-73-2	µg/L	--	--	--	--	--	
	32598-14-4	µg/L	--	--	--	--	--	
	74472-37-0	µg/L	--	--	--	--	--	

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Group	CAS No.	Units	Surface Water Screening Levels					
			Primary Screening Level [a]		Ocean Plan Screening Criteria[b]			
			Value	Source	Protection of Human Health	Protection of Marine Aquatic Life	Selected Value	
	57465-28-8	µg/L	--	--	--	--	--	
	38380-07-3	µg/L	--	--	--	--	--	
	35065-28-2	µg/L	--	--	--	--	--	
	35065-27-1	µg/L	--	--	--	--	--	
	38380-08-4	µg/L	--	--	--	--	--	
	69782-90-7	µg/L	--	--	--	--	--	
	52663-72-6	µg/L	--	--	--	--	--	
	32774-16-6	µg/L	--	--	--	--	--	
	35065-30-6	µg/L	--	--	--	--	--	
	37680-65-2	µg/L	--	--	--	--	--	
	35065-29-3	µg/L	--	--	--	--	--	
	52663-68-0	µg/L	--	--	--	--	--	
	39635-31-9	µg/L	--	--	--	--	--	
	52663-78-2	µg/L	--	--	--	--	--	
	40186-72-9	µg/L	--	--	--	--	--	
	7012-37-5	µg/L	--	--	--	--	--	
	41464-39-5	µg/L	--	--	--	--	--	
	35693-99-3	µg/L	--	--	--	--	--	
	32598-10-0	µg/L	--	--	--	--	--	
	32598-13-3	µg/L	--	--	--	--	--	
	34883-43-7	µg/L	--	--	--	--	--	
	70362-50-4	µg/L	--	--	--	--	--	
	Total PCBs	µg/L	0.014	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	0.000019	--	0.000019	Ca
ides								
	72-54-8	µg/L	--	--	0.00017	--	0.00017	Ca
	72-55-9	µg/L	--	--	0.00017	--	0.00017	Ca
	50-29-3	µg/L	--	--	0.00017	--	0.00017	Ca
	309-00-2	µg/L	--	--	0.000022	--	0.000022	Ca
	319-84-6	µg/L	--	--		0.004	0.004	Ca
	5103-71-9	µg/L	--	--	--	--	--	
	1912-24-9	µg/L	--	--	--	--	--	
	319-85-7	µg/L	--	--		0.004	0.004	Ca
	319-86-8	µg/L	--	--		0.004	0.004	Ca
	60-57-1	µg/L	--	--	0.00004	--	0.00004	Ca

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Group	CAS No.	Units	Surface Water Screening Levels					
			Primary Screening Level [a]		Ocean Plan Screening Criteria[b]			
			Value	Source	Protection of Human Health	Protection of Marine Aquatic Life	Selected Value	
	1031-07-8	µg/L	--	--		0.009	0.009	Ca
	72-20-8	µg/L	--	--		0.02	0.002	Ca
	7421-93-4	µg/L	--	--	--	--	--	
	5103-74-2	µg/L	--	--	--	--	--	
	58-89-9	µg/L	--	--		0.004	0.004	Ca
	76-44-8	µg/L	--	--	0.00005	--	0.00005	Ca
	1024-57-3	µg/L	--	--	0.00002	--	0.00002	Ca
	72-43-5	µg/L	--	--	--	--	--	
	60207-90-1	µg/L	--	--	--	--	--	
	8001-35-2	µg/L	--	--	0.00021	--	0.00021	Ca
	115-86-6	µg/L	--	--	--	--	--	
	57-74-9	µg/L	--	--	0.000023	--	0.000023	Ca
l								
ol	58-90-2	µg/L	1.2	USEPA Region 5 ESLs (2003)	--	1	1	Ca
	95-95-4	µg/L	63	Freshwater Ambient Water Quality Criteria (Buchman, 2008)	--	1	1	Ca
	118-79-6	µg/L	--	--	--	--	--	
	88-06-2	µg/L	4.9	USEPA Region 5 ESLs (2003)	0.29	1	0.29	Ca
	609-19-8	µg/L	--	--	--	--	--	
	87-86-5	µg/L	15	CA Toxics Rule (40 CFR Part 131)	--	1	1	Ca
	EPADIOXTEQ(H)ND	pg/L	--	--	0.0039	--	0.0039	Ca
	1746-01-6	pg/L	--	--	0.0039	--	0.0039	Ca
	40321-76-4	pg/L	--	--	--	--	--	
	35822-46-9	pg/L	--	--	--	--	--	
	39227-28-6	pg/L	--	--	--	--	--	
	57653-85-7	pg/L	--	--	--	--	--	
	19408-74-3	pg/L	--	--	--	--	--	
	3268-87-9	pg/L	--	--	--	--	--	
	51207-31-9	pg/L	--	--	--	--	--	
	57117-41-6	pg/L	--	--	--	--	--	
	57117-31-4	pg/L	--	--	--	--	--	
	70648-26-9	pg/L	--	--	--	--	--	
	57117-44-9	pg/L	--	--	--	--	--	

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Group	CAS No.	Units	Surface Water Screening Levels: Primary Screening Level [a]: Value	Primary Screening Level [a]: Source	Ocean Plan Screening Criteria[b]: Protection of Human Health	Ocean Plan Screening Criteria[b]: Protection of Marine Aquatic Life	Ocean Plan Screening Criteria[b]: Selected Value	
	67562-39-4	pg/L	--	--	--	--	--	
	55673-89-7	pg/L	--	--	--	--	--	
	39001-02-0	pg/L	--	--	--	--	--	

iations:

	not available	OCDF	octachlorodibenzofuran
	California Environmental Protection Agency	PAH	polycyclic aromatic hydrocarbons
	Chemical Abstract Service number	PCB	polychlorinated biphenyl
	dichlorodiphenyldichloroethane	PeCDD	pentachlorodibenzo-p-dioxin
	dichlorodiphenyldichloroethylene	PeCDF	pentachlorodibenzofuran
	dichlorodiphenyl trichloroethane	pg/L	picograms per liter
	environmental screening level	SVOC	semivolatile organic compound
	high molecular weight	TEQ	toxic equivalent
	hexachlorodibenzo-p-dioxin	µg/L	micrograms per liter
	hexachlorodibenzofuran	USEPA	United States Environmental Protection Agency
	methyl tertiary-butyl ether	VOC	volitile organic compound
	octachlorodibenzo-p-dioxin		

ues are California Toxics Rule value when available, otherwise freshwater Ambient Water Quality Criteria (Buchman, 2008), unless otherwise noted.

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Table D-7
Inland Surface Water Quality Criteria

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Inland Surface Water WQO	
			Value	Source
Metals				
Antimony	7440-36-0	µg/L	6	US EPA NAWQC
Arsenic	7440-38-2	µg/L	10	CA Primary MCL
Barium	7440-39-3	µg/L	1000	CA Primary MCL
Cadmium	7440-43-9	µg/L	0.04	OEHHA PHG
Chromium	7440-47-3	µg/L	50	OEHHA PHG
Cobalt	7440-48-4	µg/L	50	Ag WQL
Copper	7440-50-8	µg/L	9	CA Toxics Rule
Lead	7439-92-1	µg/L	0.2	OEHHA PHG
Mercury	7439-97-6	µg/L	0.05	CA Toxics Rule
Molybdenum	7439-98-7	µg/L	10	Ag WQL
Nickel	7440-02-0	µg/L	52	CA Toxics Rule
Selenium	7782-49-2	µg/L	5	CA Toxics Rule
Silver	7440-22-4	µg/L	3.4	CA Toxics Rule
Thallium	7440-28-0	µg/L	1.7	CA Toxics Rule
Vanadium	7440-62-2	µg/L	50	CA Toxics Rule
Zinc	7440-66-6	µg/L	120	CA Toxics Rule
Volatile Organic Compounds (VOCs)				
1,4-Dichlorobenzene	106-46-7	µg/L	5	CA Primary MCL
Acetone	67-64-1	µg/L	6300	IRIS RfD
Bromomethane	74-83-9	µg/L	48	CA Toxics Rule
Ethanol	64-17-5	µg/L	760000	T&O Threshold
Isopropyl alcohol (manufacturing-strong acid	67-63-0	µg/L	160000	T&O Threshold
Isopropylbenzene	98-82-8	µg/L	0.8	T&O Threshold
m,p-Xylenes	1330-20-7	µg/L	17	T&O Threshold
Methylene Chloride	75-09-2	µg/L	4.7	CA Toxics Rule
Para-Isopropyl Toluene	99-87-6	µg/L	NA	NA
Toluene	108-88-3	µg/L	42	T&O Threshold
Xylenes, Total	1330-20-7	µg/L	17	T&O Threshold
Polycyclic Aromatic Hydrocarbons (PAHs)				
Acenaphthylene	208-96-8	µg/L	NA	NA
Anthracene	120-12-7	µg/L	9600	CA Toxics Rule
Benzo(a)anthracene	56-55-3	µg/L	0.0044	CA Toxics Rule
Benzo(a)pyrene	50-32-8	µg/L	0.0044	CA Toxics Rule
Benzo(b)fluoranthene	205-99-2	µg/L	0.0044	CA Toxics Rule
Benzo(g,h,i)perylene	191-24-2	µg/L	NA	NA
Benzo(k)fluoranthene	207-08-9	µg/L	0.0044	CA Toxics Rule
Chrysene	218-01-9	µg/L	0.0044	CA Toxics Rule
Dibenz(a,h)anthracene	53-70-3	µg/L	0.0044	CA Toxics Rule
Fluoranthene	206-44-0	µg/L	300	CA Toxics Rule
Fluorene	86-73-7	µg/L	1300	CA Toxics Rule
Indeno(1,2,3-cd)Pyrene	193-39-5	µg/L	0.0044	CA Toxics Rule

Table D-7
Inland Surface Water Quality Criteria

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Inland Surface Water WQO	
			Value	Source
Naphthalene	91-20-3	µg/L	17	CA Notification Level
Phenanthrene	85-01-8	µg/L	NA	NA
Pyrene	129-00-0	µg/L	960	CA Toxics Rule
B(a)P TEQ	--	µg/L	0.0044	CA Toxics Rule
Semivolatile Organic Compounds (SVOCs)				
4-Methylphenol	106-44-5	µg/L	NA	NA
Canadian Pulp Method				
Pentachlorophenol	87-86-5	µg/L	0.28	CA Notification Level
Dioxins and Furans				
2,3,7,8 TCDD TEQ	EPADIOXTEQ(H)ND	pg/L	0.013	CA Toxics Rule
2,3,7,8-TCDD (Dioxin)	1746-01-6	pg/L	0.013	CA Toxics Rule
1,2,3,4,6,7,8-HpCDD	35822-46-9	pg/L	NA	NA
1,2,3,4,7,8-HxCDD	39227-28-6	pg/L	NA	NA
1,2,3,6,7,8-HxCDD	57653-85-7	pg/L	NA	NA
1,2,3,7,8,9-HxCDD	19408-74-3	pg/L	NA	NA
OCDD	3268-87-9	pg/L	NA	NA
2,3,7,8-TCDF	51207-31-9	pg/L	NA	NA
2,3,4,7,8-PeCDF	57117-31-4	pg/L	NA	NA
1,2,3,6,7,8-HxCDF	57117-44-9	pg/L	NA	NA
2,3,4,6,7,8-HxCDF	60851-34-5	pg/L	NA	NA
1,2,3,4,6,7,8-HpCDF	67562-39-4	pg/L	NA	NA
1,2,3,4,7,8,9-HpCDF	55673-89-7	pg/L	NA	NA
OCDF	39001-02-0	pg/L	NA	NA

Table D-7
Inland Surface Water Quality Criteria

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent/Analytical Group	CAS No.	Units	Inland Surface Water WQO	
			Value	Source

Acronyms and Abbreviations:

Ag WQL	Agricultural Water Quality Limits
CA Notification Level	California State Notification Level (formerly Action Level)
CA Primary MCL	California Department of Public Health Primary MCL
CA Toxics Rule	California Toxics Rule
Cas. No.	Chemical Abstract Service number
CVWQCB T&O	CVRWQCB (2004) TPH water quality objectives for taste and odor
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyl trichloroethane
IRIS CRE	USEPA Integrated Risk Information System (IRIS) One-in-a-million Incremental Cancer Risk Estimate For Drinking Water
IRIS RfD	USEPA Integrated Risk Information System (IRIS) Reference Dose as Drinking Water Level
HpCDD	heptachlorodibenzo-p-dioxin
HpCDF	heptachlorodibenzofuran
Hx-CDD	hexachlorodibenzo-p-dioxin
HxCDF	hexachlorodibenzofuran
MCL	Maximum Contaminant Level
Obj	Objective
--	Not available
NA	Not available
Obj	objective
OCDD	octachlorodibenzo-p-dioxin
OCDF	octachlorodibenzofuran
OEHHA PHG	Office of Environmental Health and Safety Public Health Goal
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pg/L	picograms per liter
PHG	public health goal
SVOC	semivolatile organic compund
TCDD	tetrachlorodibenzo-p-dioxin
TEQ	toxic equivalent
T&O	taste and odor
µg/L	micrograms per liter
USEPA	United States Environmental Protection Agency
VOC	volitile organic compound

Table D-8
Total Petroleum Hydrocarbon Screening Levels for Soil and Groundwater

Draft Remedial Investigation Report Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

	Soil TPH Screening Levels			Groundwater TPH Screening	
Constituent	Direct Contact RBSC [a]	Direct Contact and Indoor Air RBSC [a]	Leaching to Groundwater Criteria [b]	Groundwater RBSC [a]	RWQCB TPH Limits
Units	mg/kg	mg/kg	mg/kg	mg/L	mg/L
Aliphatics					
TPH as Gasoline (C6-C8)	5627	2.6	--	0.597	--
TPH as Gasoline (C8-C10)	14066	9.8	--	1.22	--
Total Gasoline (C6-C10)	14066	9.8	--	1.22	0.05 [c]
TPH as Gasoline (C7-C12)	14066	9.8	--	1.22	0.05 [c]
TPH as Diesel (C10-C12)	14066	51	--	1.22	--
TPH as Diesel (C12-C16)	14066	648	--	1.22	--
TPH as Diesel (C16-C24)	14066	10772	--	1.22	--
Total Diesel (C10-C24)	14066	10772	1045	1.22	0.1 [d]
TPH as Diesel (C10-C24)	14066	10772	1045	1.22	0.1 [d]
TPH as Motor Oil (C24-36)	281346	281346	--	31.3	0.175 [e]
Aromatics					
TPH as Gasoline (C6-C8)	NA	NA	--	NA	--
TPH as Gasoline (C8-C10)	4220	1.6	--	0.31	--
Total Gasoline (C6-C10)	4220	1.6	--	0.31	0.05 [c]
TPH as Gasoline (C7-C12)	4220	1.6	--	0.31	0.05 [c]
TPH as Diesel (C10-C12)	4220	8.5	--	0.31	--
TPH as Diesel (C12-C16)	4220	110	--	0.31	--
TPH as Diesel (C16-C24)	4220	4220	--	0.47	--
Total Diesel (C10-C24)	4220	4220	1045	0.47	0.1 [d]
TPH as Diesel (C10-C24)	4220	4220	1045	0.47	0.1 [d]
TPH as Motor Oil (C24-36)	4220	4220	--	0.47	0.175 [e]

Acryonyms and Abbreviations:

CVRWQCB	Central Valley Region Water Quality Control Board
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NCRWQCB	North Coast Regional Water Quality Control Board
RBSC	Risk Based Screening Criteria
RWQCB	Regional Water Quality Control Board
TPH	total petroleum hydrocarbon
µg/L	micrograms per liter

Notes:

a. Site-specific risk-based screening concentrations (RBSCs, [ARCADIS BBL, 2008]). Total Gasoline, the sum of TPH as gasoline (TPHg) ranges C6-C8 and C8-C10, and TPHg reported as the C7-C12 range are compared to the RBSCs for the C8-C10 range. Total Diesel, the sum of TPH as Diesel (TPHd) ranges C10-C12, C12-C16 and C16-C24, and TPHd reported as the C10-C24 range are compared to the RBSCs for the C16-C24 range.

b. From ARCADIS, 2010. Upper bound concentration that would result in leachate concentrations less than the RWQCB TPH Limit of 0.1 mg/L.

c. Actual criteria (taste and odor threshold: 5 µg/L; CVRWQCB, 2004) is lower than the detection limit. As communicated by the NCRWQCB (2008) the detection limit of 50 µg/L is used as screening value for TPH as gasoline (C6-C10).

d. North Coast RWQCB Water Quality Numerical Limits for Petroleum Fuel Mixtures, Constituents and Additives (CVRWCQB, 2004; NCRWQCB 2010), taste and odor threshold.

e. Reporting limit based on taste and odor threshold; personal communication from NCRWQCB (2008).

References:

ARCADIS. 2010. Site-Specific TPH Leaching Evaluation, Former Georgia-Pacific Wood Products Facility, Fort Bragg, California. Prepared for Georgia-Pacific LLC. ARCADIS U.S., Inc. February.

ARCADIS BBL. 2008. Site-Wide Risk Assessment Work Plan, Former Georgia-Pacific Wood Products Facility, Fort Bragg, California. Prepared for Georgia-Pacific LLC. ARCADIS U.S., Inc. Original version: October 2007. Revised version: May.

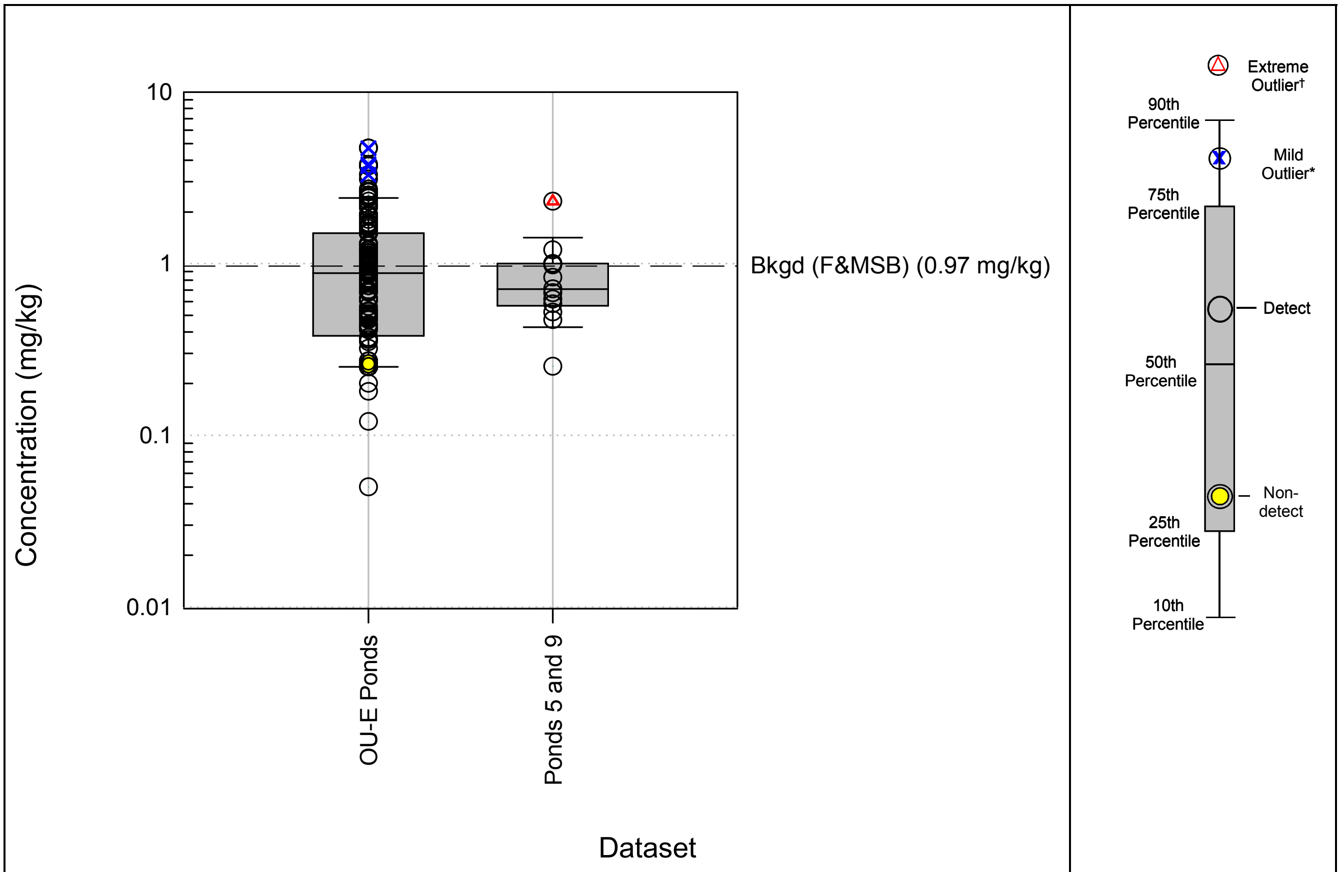
CVRWQCB. 2004. Memo from Jon B. Marshack, D. Env., Staff Environmental Scientist, Program Support Unit, to Technical Staff and Other Interested Persons, re: Beneficial Use–Protective Water Quality Limits for Components of Petroleum-Based Fuels. California Regional Water Quality Control Board, Central Valley Region. April 1.

NCRWQCB. 2008. Personal communication. Electronic mail from Dr. Craig Hunt, Water Resource Control Engineer, to Mr. Edgardo Gillera, Hazardous Substances Scientist, Department of Toxic Substances Control, re: Georgia-Pacific Draft IRA Comments. California Regional Water Quality Control Board, North Coast Region. January 29. (Electronic mail forwarded by Mr. Gillera to Ms. Bridgette DeShields and Ms. Judy Nedoff of ARCADIS on February 4, 2008.)

NCRWQCB. 2010. Letter from Mr. Craig Hunt, Water Resource Control Engineer, to Mr. Tom Lanphar, Senior Hazardous Substances Scientist, Brownfields and Environmental Restoration Program, Department of Toxic Substances Control, re: Water Quality Objectives Site: Georgia-Pacific Fort Bragg Sawmill, 90 West Redwood Ave, Fort Bragg, California. RWQCB Case No. 1NMC462. California Regional Water Quality Control Board, North Coast Region. March 2.

Figures

Appendix D - Selection of Screening Level Values for Data Evaluation



ARCADIS

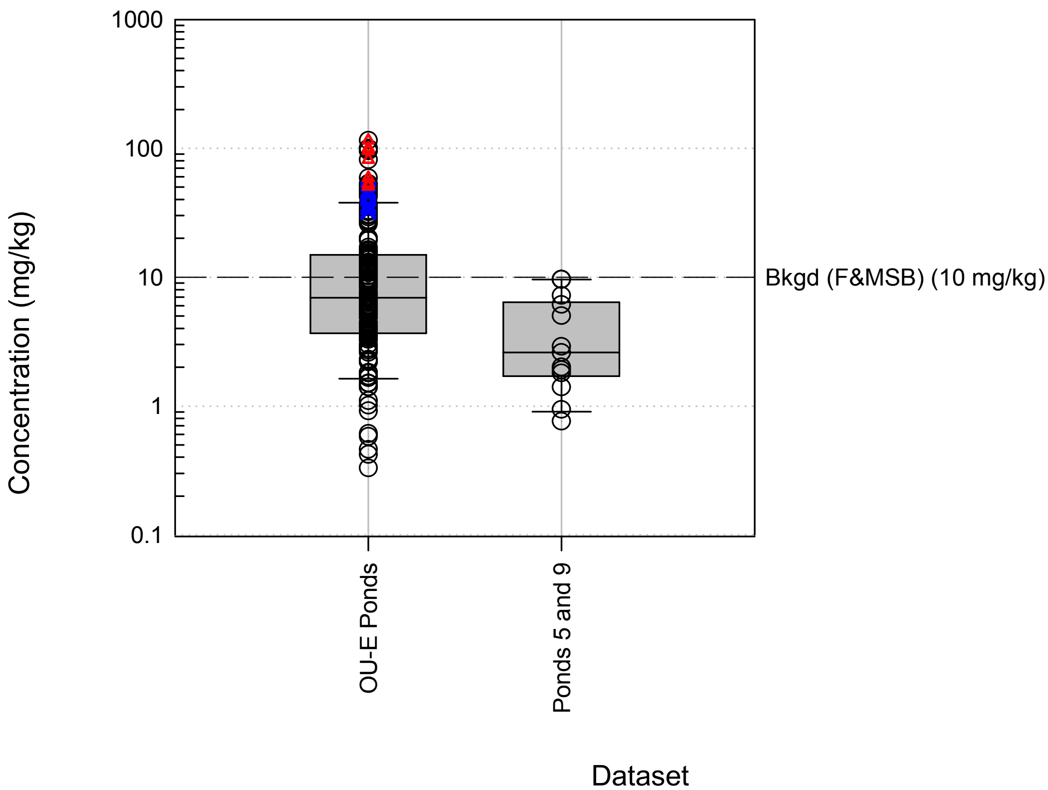
Box and Whisker Plot
Antimony
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

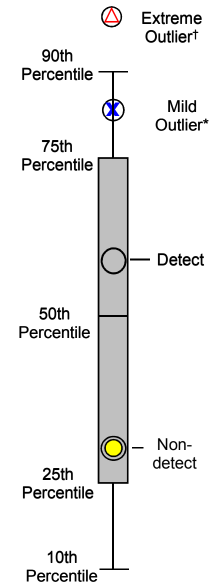
Figure D-1

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	26	117	143	0.25	0.27	0.05	4.7	1.3	1.00	0.92	0.38	0.88	1.5
Ponds 5 and 9	mg/kg	0	13	13	NA	NA	0.25	2.3	0.86	0.71	0.51	0.57	0.71	1.00

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR
-- = no data
Bkgd = Background
F = Fill
IQR = Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg = milligrams per kilogram
MSB = Marine Sediments / Bedrock
NA = Value not applicable due to frequency of detection
ND = Non-detect
Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.

Attachment D-1
Pond Sediments Box and Whisker Plots
Metals





ARCADIS

Box and Whisker Plot
Arsenic
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

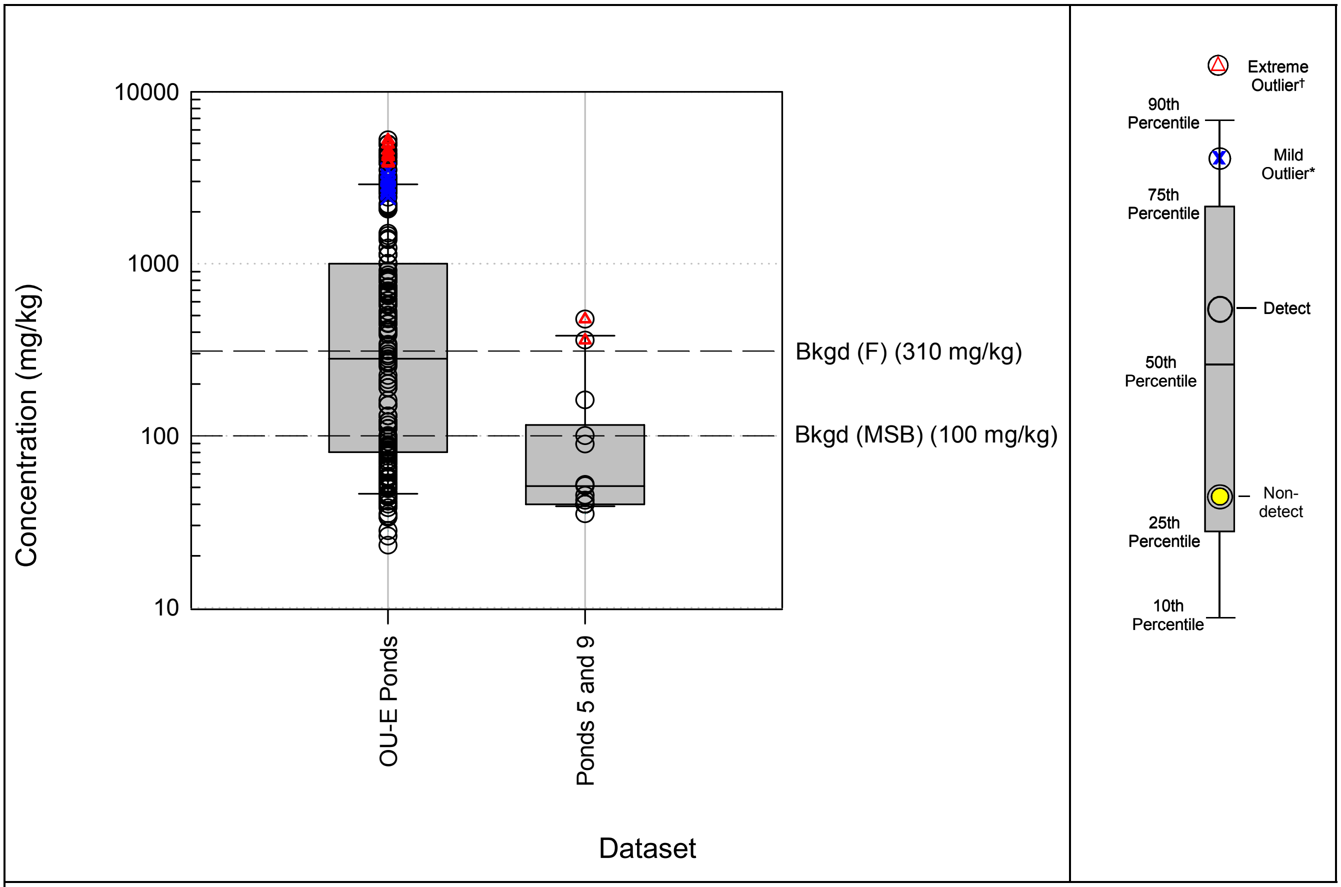
Figure D-2

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	0	143	143	NA	NA	0.33	115	15.2	6.9	21.4	3.7	6.9	14.9
Ponds 5 and 9	mg/kg	0	13	13	NA	NA	0.76	9.6	4.0	2.6	3.2	1.7	2.6	6.4

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR

--	= no data
Bkgd	= Background
F	= Fill
IQR	= Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg	= milligrams per kilogram
MSB	= Marine Sediments / Bedrock
NA	= Value not applicable due to frequency of detection
ND	= Non-detect

Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.



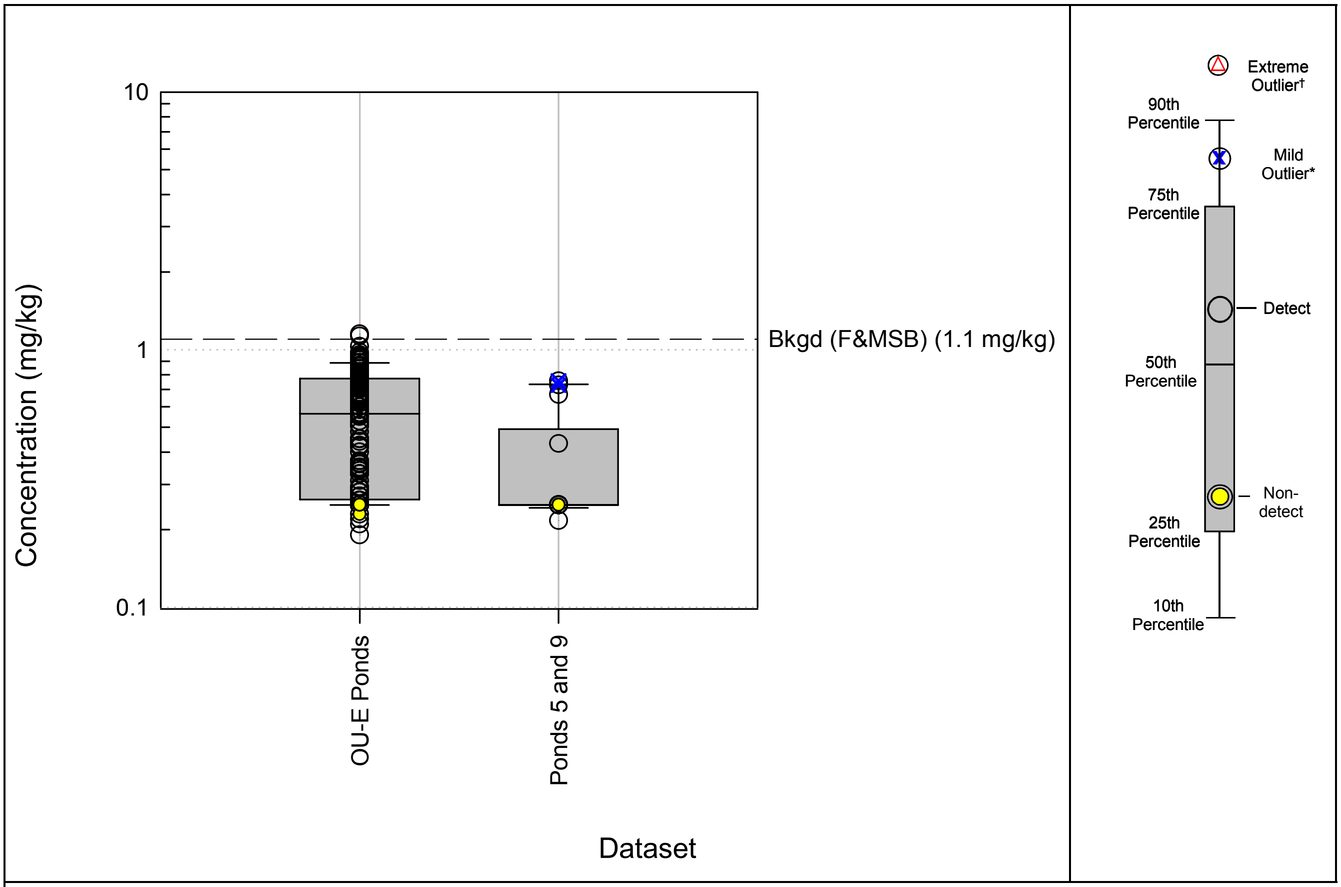
ARCADIS

Box and Whisker Plot
Barium
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

Figure D-3

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	0	143	143	NA	NA	23.0	5,240	894	280	1,273	80.3	280	1,000
Ponds 5 and 9	mg/kg	0	13	13	NA	NA	35.0	475	118	51.0	140	40.0	51.0	115

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR
-- = no data
Bkgd = Background
F = Fill
IQR = Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg = milligrams per kilogram
MSB = Marine Sediments / Bedrock
NA = Value not applicable due to frequency of detection
ND = Non-detect
Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.



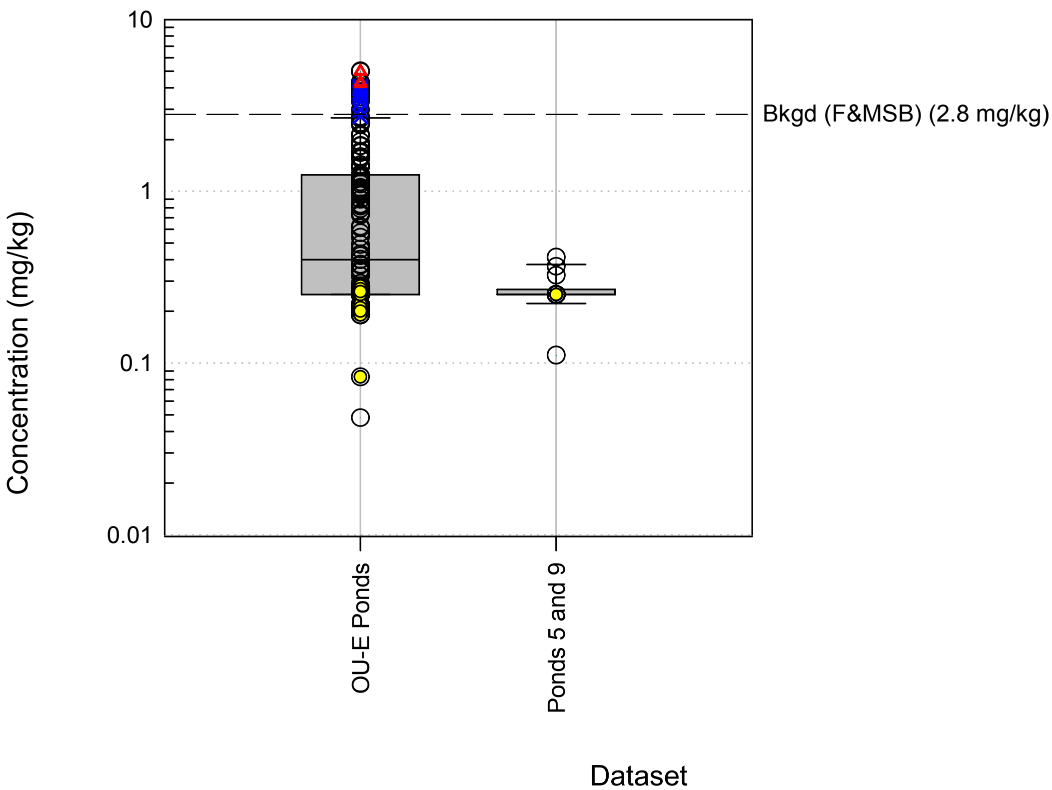
ARCADIS

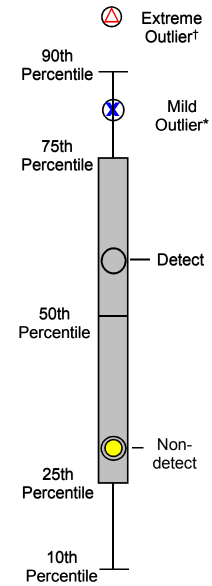
Box and Whisker Plot
Beryllium
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

Figure D-4

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	27	116	143	0.23	0.25	0.19	1.2	0.61	0.64	0.24	0.26	0.56	0.77
Ponds 5 and 9	mg/kg	8	5	13	0.25	0.25	0.22	0.76	0.56	0.67	0.23	0.25	0.25	0.49

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR
-- = no data
Bkgd = Background
F = Fill
IQR = Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg = milligrams per kilogram
MSB = Marine Sediments / Bedrock
NA = Value not applicable due to frequency of detection
ND = Non-detect
Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.





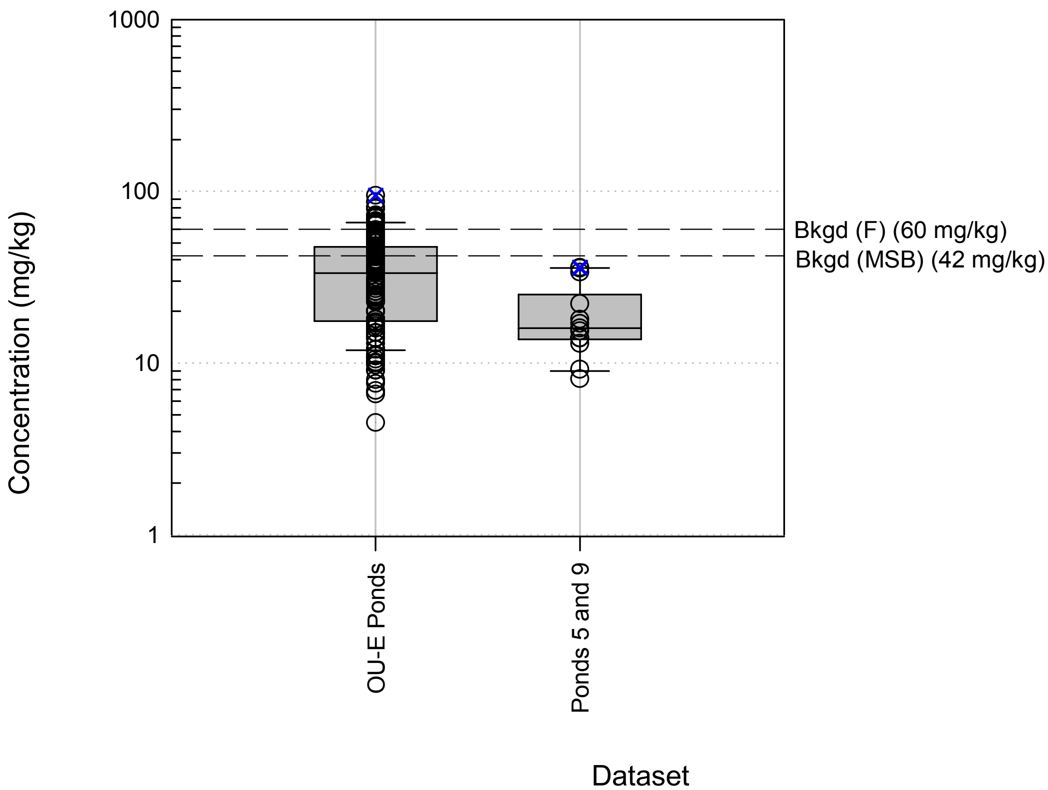
ARCADIS

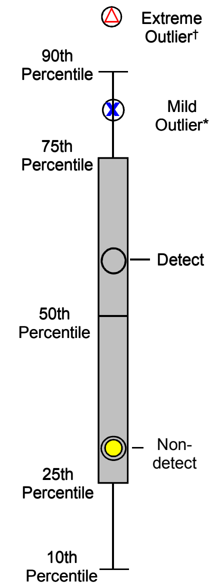
Box and Whisker Plot
Cadmium
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

Figure D-5

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	57	86	143	0.08	0.28	0.05	5.0	1.5	1.1	1.2	0.25	0.40	1.2
Ponds 5 and 9	mg/kg	9	4	13	0.25	0.25	0.11	0.41	0.30	0.34	0.13	0.25	0.25	0.27

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR
-- = no data
Bkgd = Background
F = Fill
IQR = Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg = milligrams per kilogram
MSB = Marine Sediments / Bedrock
NA = Value not applicable due to frequency of detection
ND = Non-detect
Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.





ARCADIS

Box and Whisker Plot
Chromium
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

Figure D-6

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	0	143	143	NA	NA	4.5	94.5	35.0	33.4	20.1	17.5	33.4	47.4
Ponds 5 and 9	mg/kg	0	13	13	NA	NA	8.1	36.0	19.4	16.0	9.6	13.8	16.0	25.0

Notes:

† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR

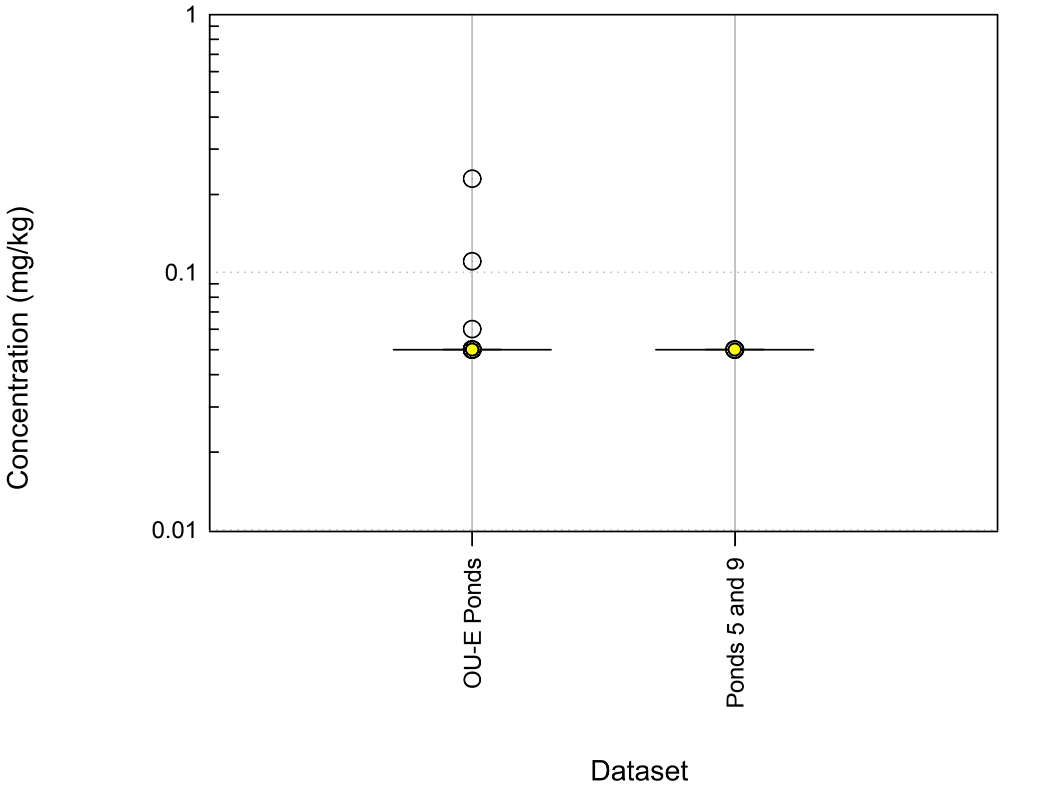
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR

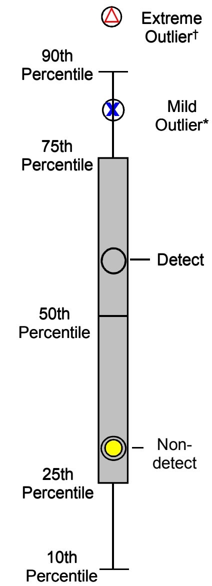
--	= no data
Bkgd	= Background
F	= Fill
IQR	= Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg	= milligrams per kilogram
MSB	= Marine Sediments / Bedrock
NA	= Value not applicable due to frequency of detection
ND	= Non-detect

Reporting limit is used for non-detects unless otherwise noted.

Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.

OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.





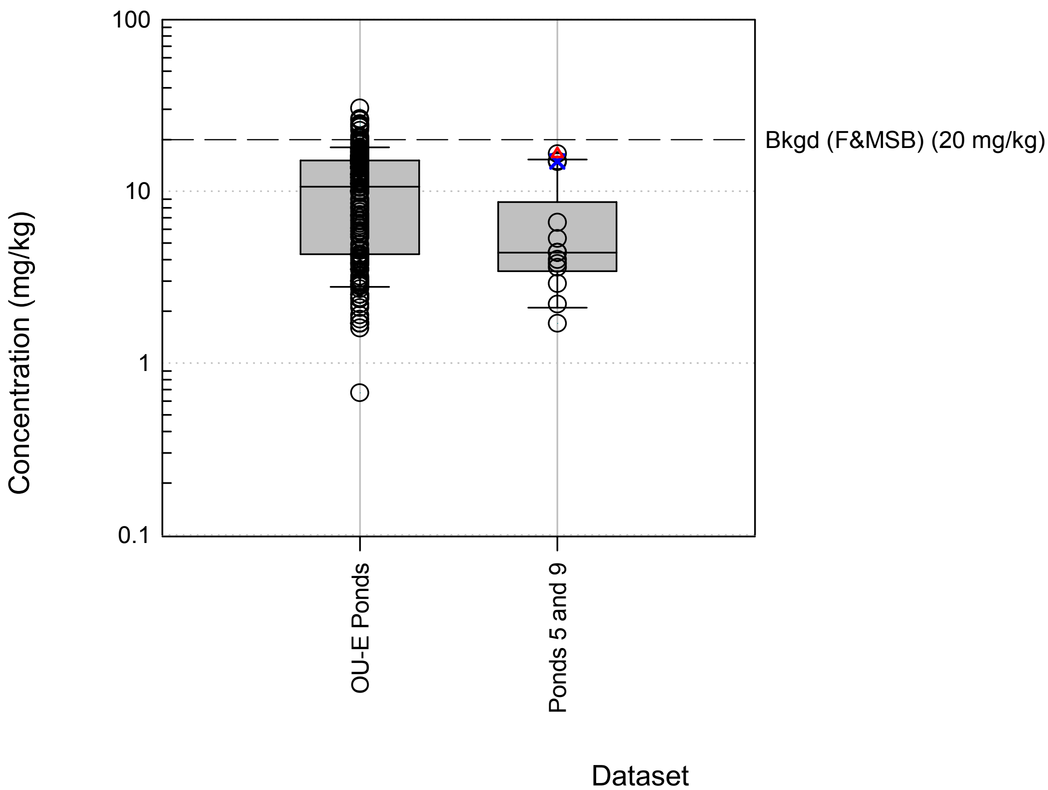
ARCADIS

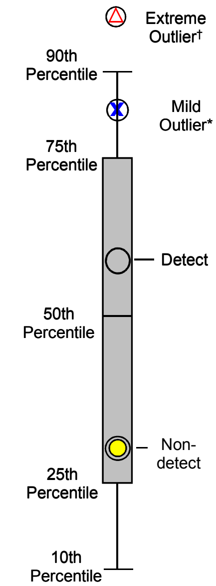
Box and Whisker Plot
Chromium VI
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

Figure D-7

		Sample Size			ND Range		Detects					Percentiles (All Data)		
Dataset	Units	NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	65	3	68	0.05	0.05	0.06	0.23	0.13	0.11	0.09	0.05	0.05	0.05
Ponds 5 and 9	mg/kg	9	0	9	0.05	0.05	ND	ND	ND	ND	ND	0.05	0.05	0.05

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR
-- = no data
Bkgd = Background
F = Fill
IQR = Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg = milligrams per kilogram
MSB = Marine Sediments / Bedrock
NA = Value not applicable due to frequency of detection
ND = Non-detect
Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.





ARCADIS

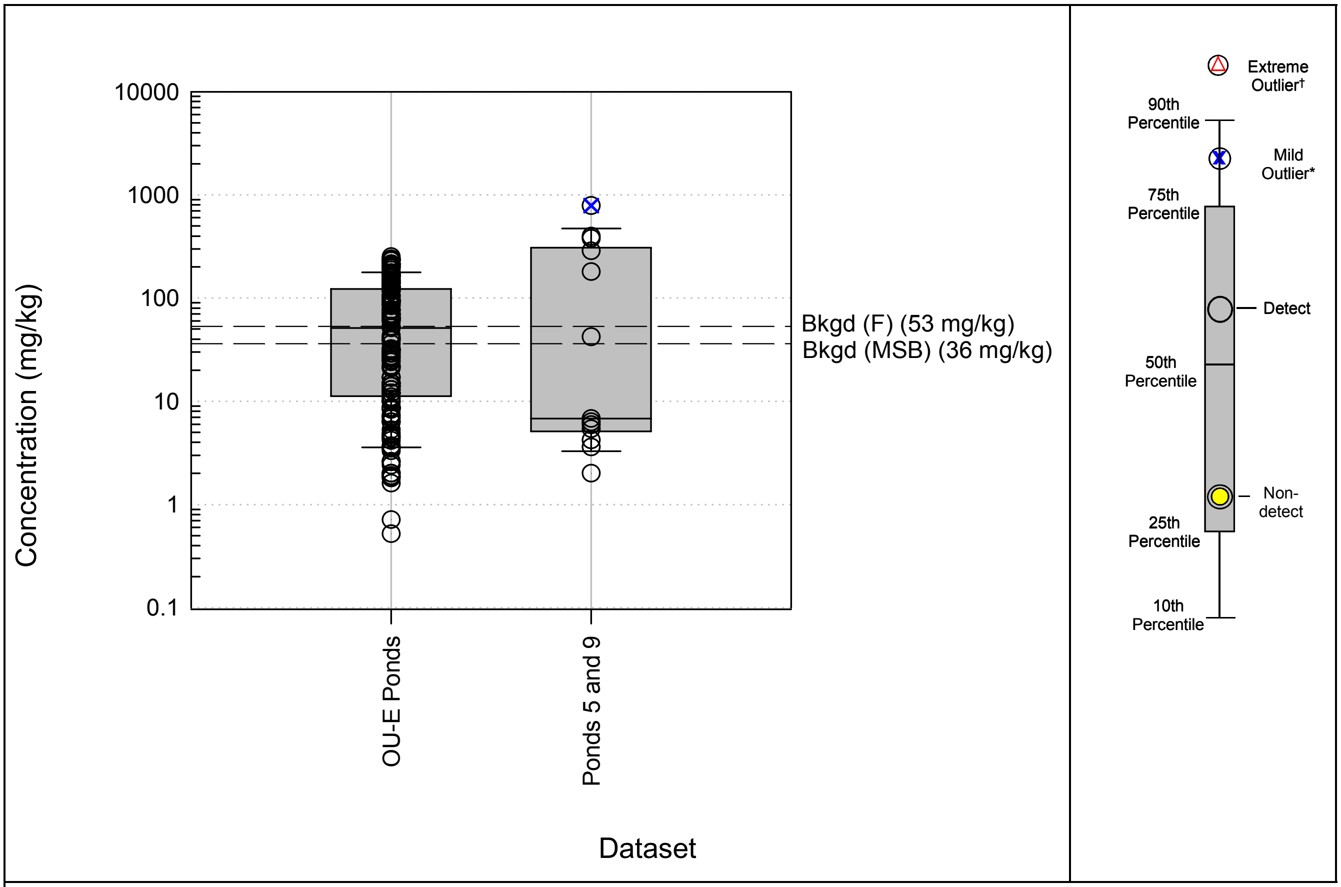
Box and Whisker Plot
Cobalt
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

Figure D-8

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	0	143	143	NA	NA	0.67	30.4	10.6	10.6	6.4	4.3	10.6	15.1
Ponds 5 and 9	mg/kg	0	13	13	NA	NA	1.7	16.5	6.6	4.4	5.2	3.4	4.4	8.6

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR
-- = no data
Bkgd = Background
F = Fill
IQR = Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg = milligrams per kilogram
MSB = Marine Sediments / Bedrock
NA = Value not applicable due to frequency of detection
ND = Non-detect
Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.

Attachment D-1
Pond Sediments Box and Whisker Plots
Metals



ARCADIS

Box and Whisker Plot
Copper
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

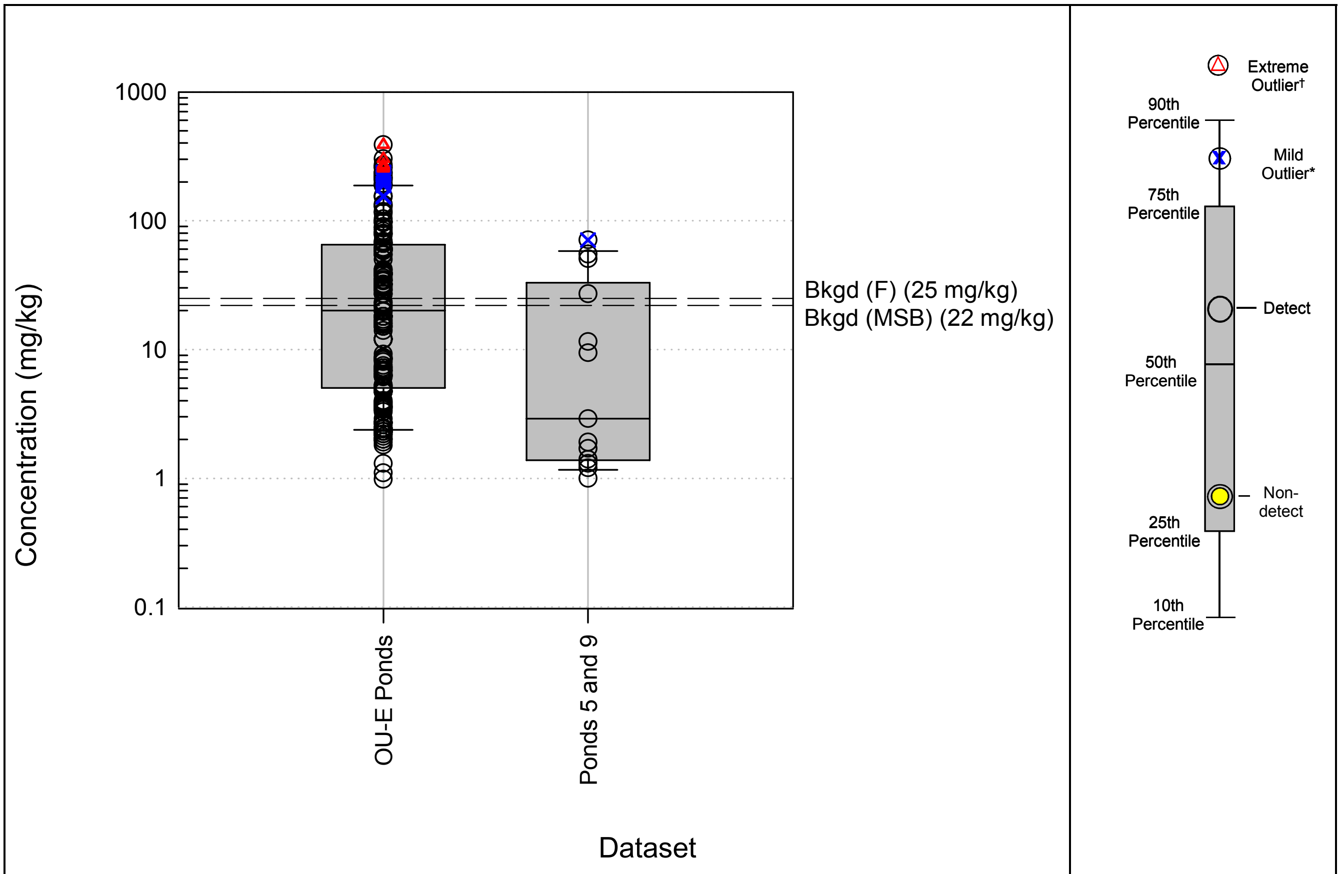
Figure D-9

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	0	143	143	NA	NA	0.52	251	71.5	51.5	69.9	11.3	51.5	123
Ponds 5 and 9	mg/kg	0	13	13	NA	NA	2.0	785	162	6.8	240	5.1	6.8	309

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR

--	= no data
Bkgd	= Background
F	= Fill
IQR	= Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg	= milligrams per kilogram
MSB	= Marine Sediments / Bedrock
NA	= Value not applicable due to frequency of detection
ND	= Non-detect

Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.



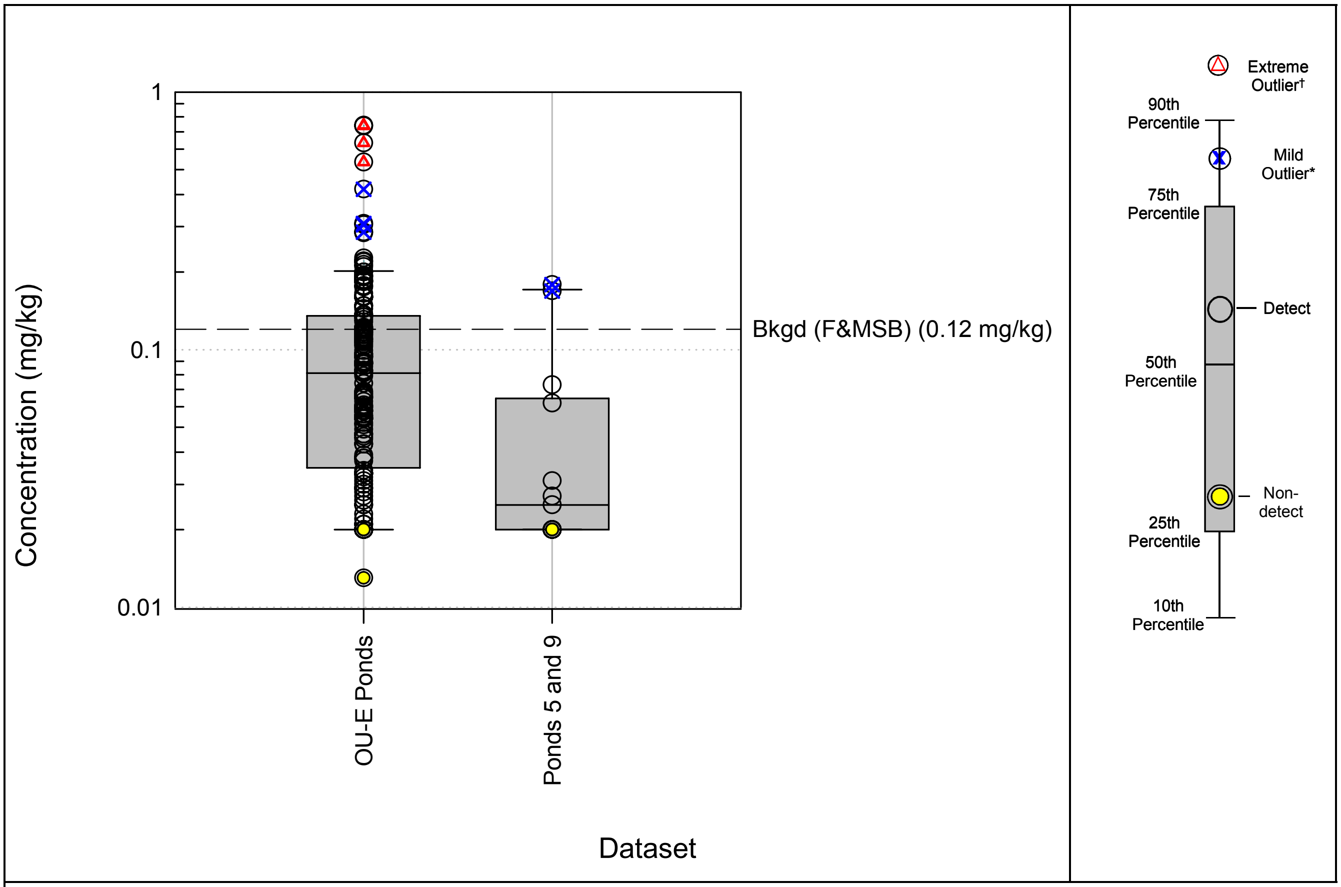
ARCADIS

Box and Whisker Plot
Lead
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

Figure D-10

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	0	143	143	NA	NA	0.98	389	53.0	20.0	74.5	5.0	20.0	65.1
Ponds 5 and 9	mg/kg	0	13	13	NA	NA	1.00	70.8	18.1	2.9	24.6	1.4	2.9	32.9

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR
-- = no data
Bkgd = Background
F = Fill
IQR = Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg = milligrams per kilogram
MSB = Marine Sediments / Bedrock
NA = Value not applicable due to frequency of detection
ND = Non-detect
Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.



ARCADIS

Box and Whisker Plot
Mercury
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

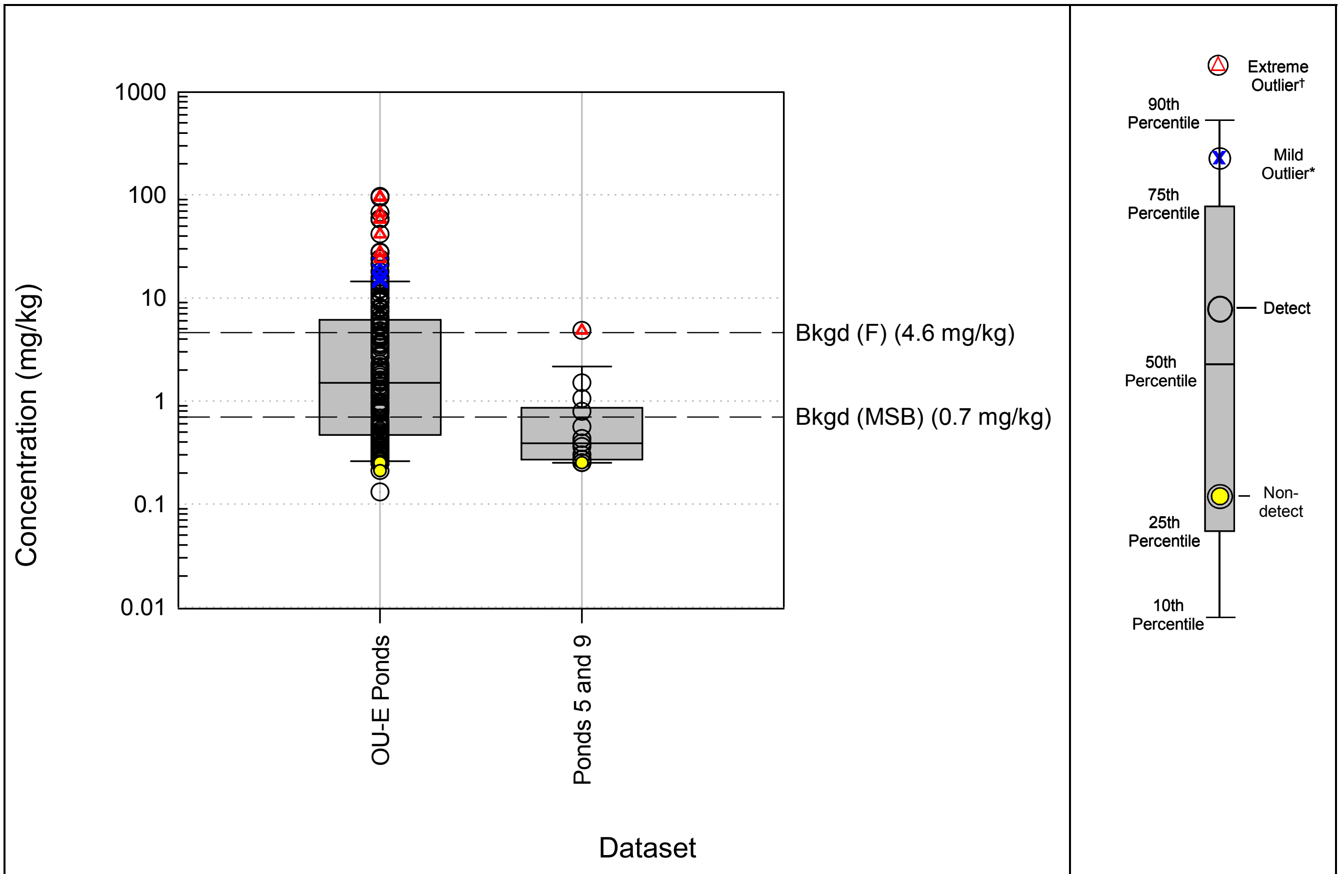
Figure D-11

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	17	126	143	0.01	0.02	0.02	0.74	0.12	0.09	0.12	0.04	0.08	0.14
Ponds 5 and 9	mg/kg	6	7	13	0.02	0.02	0.03	0.18	0.08	0.06	0.07	0.02	0.03	0.07

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR

--	= no data
Bkgd	= Background
F	= Fill
IQR	= Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg	= milligrams per kilogram
MSB	= Marine Sediments / Bedrock
NA	= Value not applicable due to frequency of detection
ND	= Non-detect

Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.



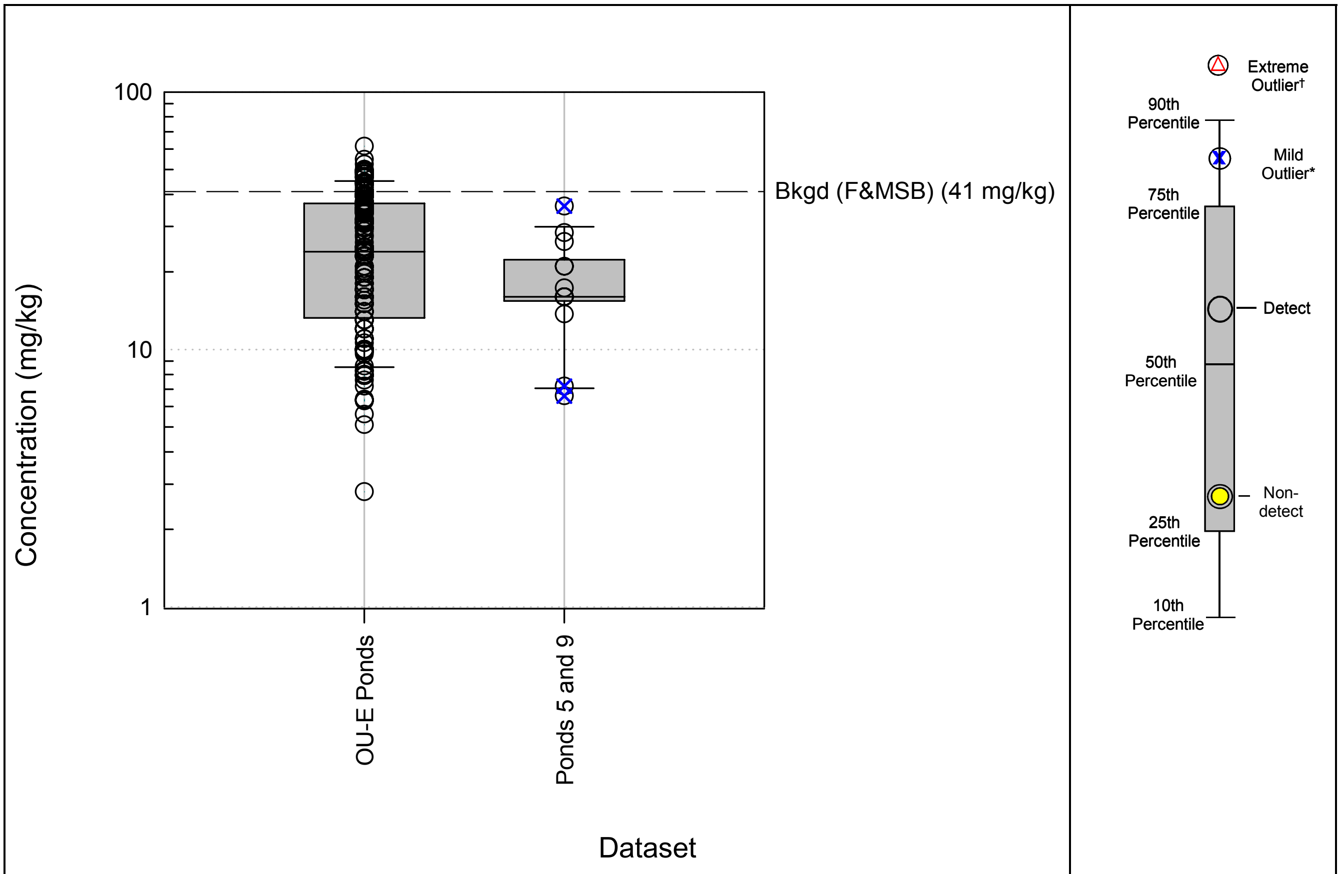
ARCADIS

Box and Whisker Plot
Molybdenum
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

Figure D-12

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	15	128	143	0.21	0.27	0.13	96.4	7.5	2.0	15.5	0.47	1.5	6.1
Ponds 5 and 9	mg/kg	1	12	13	0.25	0.25	0.25	4.8	0.92	0.41	1.3	0.27	0.39	0.86

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR
-- = no data
Bkgd = Background
F = Fill
IQR = Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg = milligrams per kilogram
MSB = Marine Sediments / Bedrock
NA = Value not applicable due to frequency of detection
ND = Non-detect
Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.



ARCADIS

Box and Whisker Plot
Nickel
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

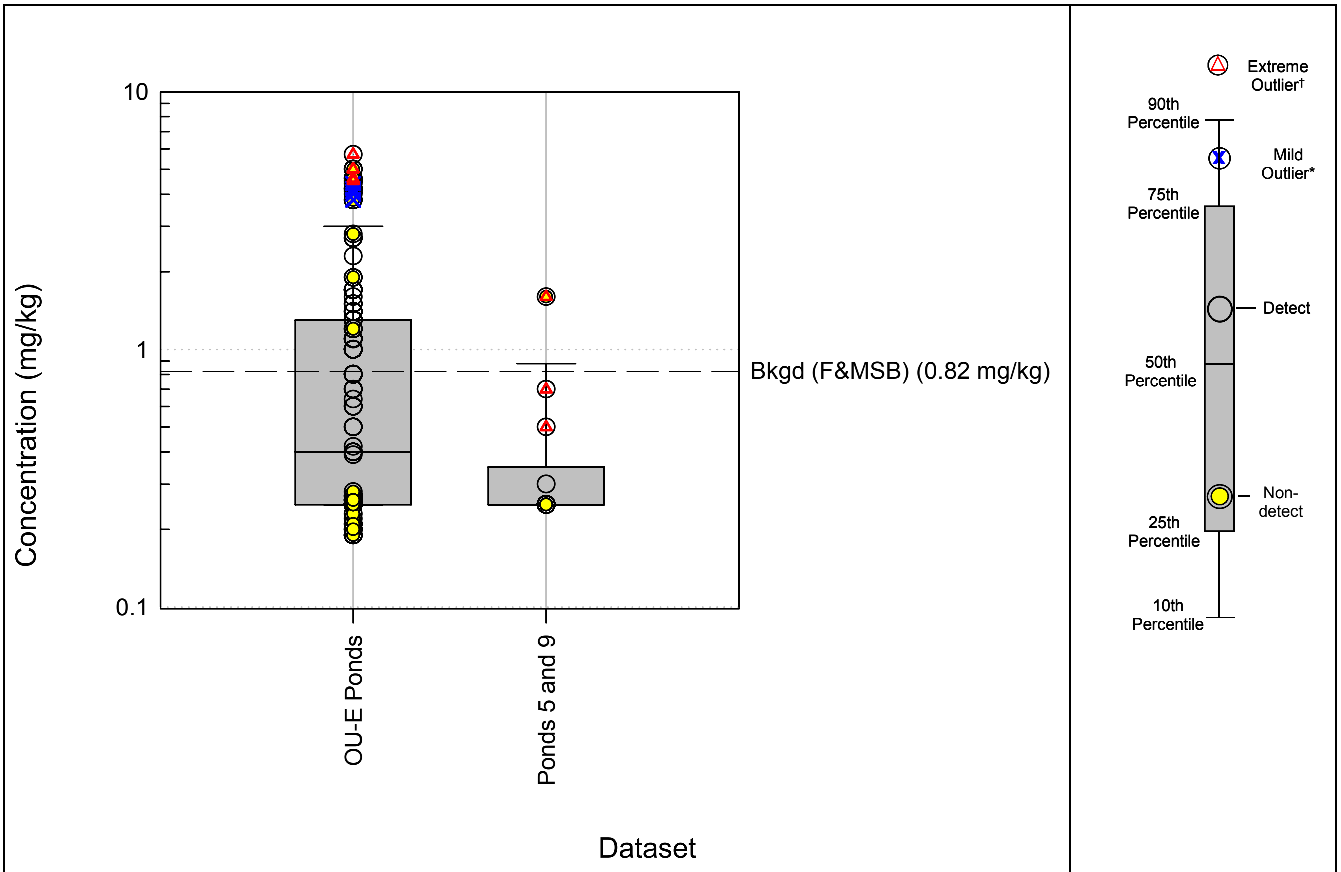
Figure D-13

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	0	143	143	NA	NA	2.8	61.5	26.0	24.0	13.9	13.3	24.0	36.9
Ponds 5 and 9	mg/kg	0	13	13	NA	NA	6.6	36.0	18.6	16.0	8.1	15.4	16.0	22.3

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR

--	= no data
Bkgd	= Background
F	= Fill
IQR	= Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg	= milligrams per kilogram
MSB	= Marine Sediments / Bedrock
NA	= Value not applicable due to frequency of detection
ND	= Non-detect

Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.



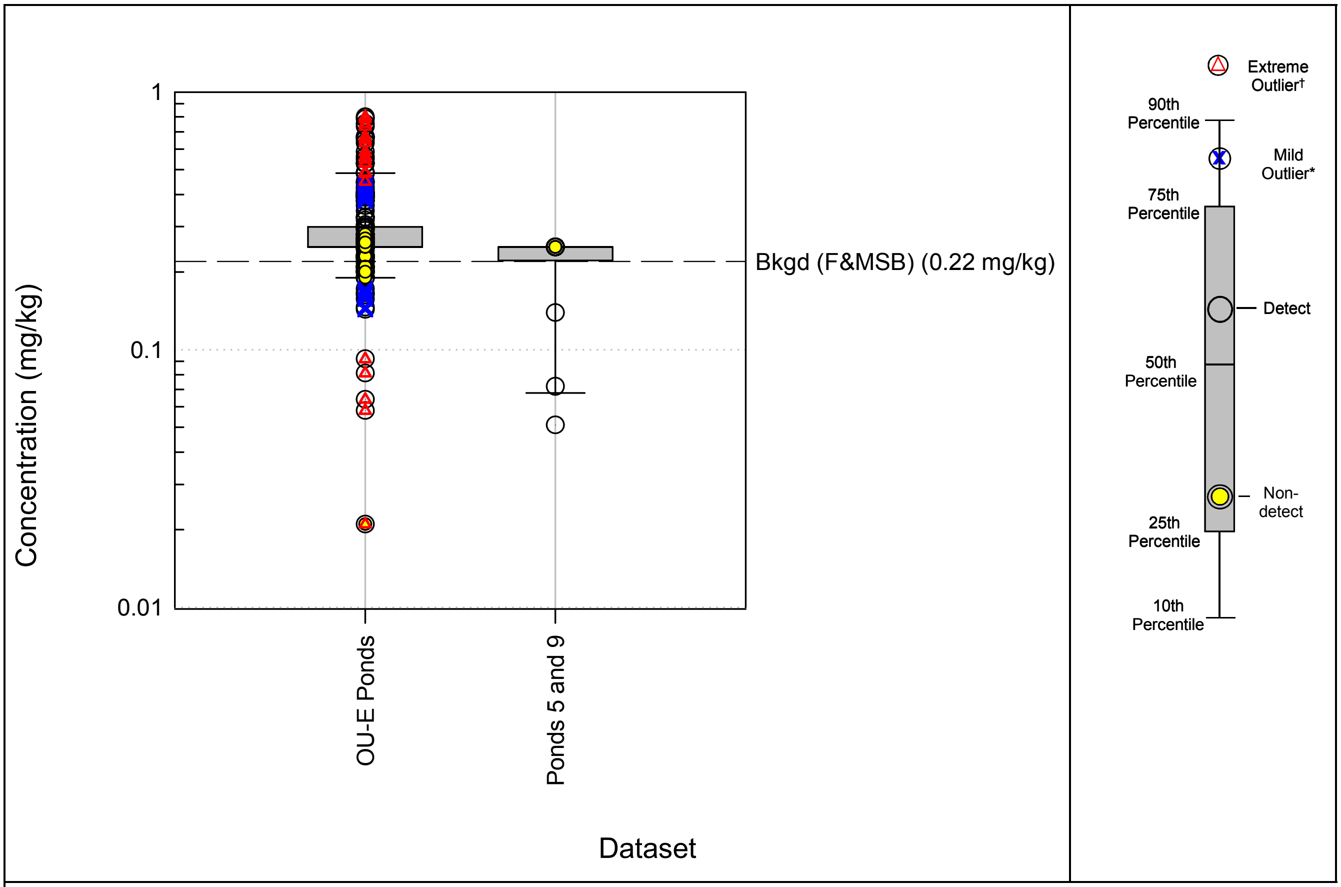
ARCADIS

Box and Whisker Plot
Selenium
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

Figure D-14

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	85	58	143	0.19	5.0	0.39	5.7	1.3	1.1	0.94	0.25	0.40	1.3
Ponds 5 and 9	mg/kg	10	3	13	0.25	1.6	0.30	0.70	0.50	0.50	0.20	0.25	0.25	0.35

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR
-- = no data
Bkgd = Background
F = Fill
IQR = Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg = milligrams per kilogram
MSB = Marine Sediments / Bedrock
NA = Value not applicable due to frequency of detection
ND = Non-detect
Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.



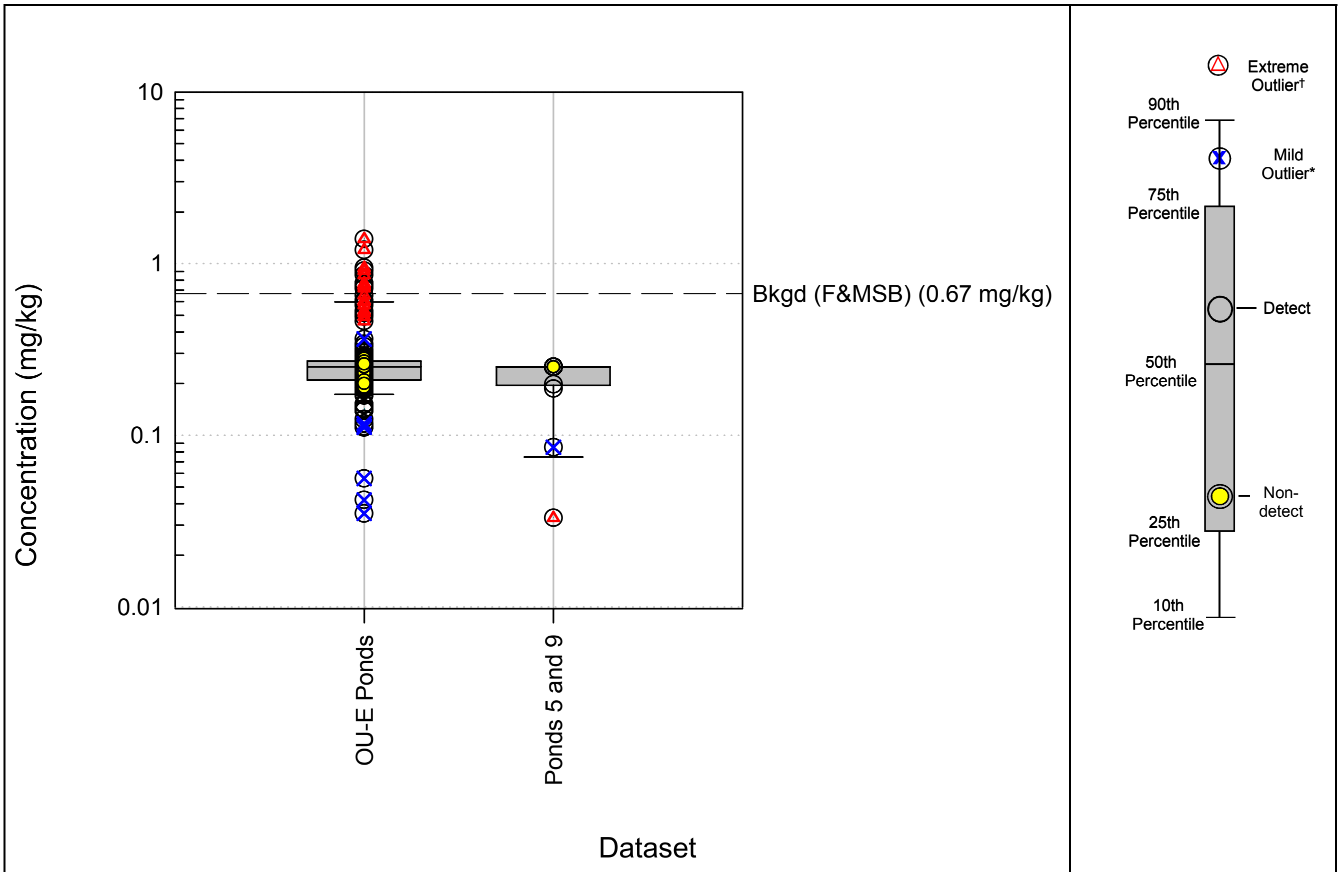
ARCADIS

Box and Whisker Plot
Silver
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

Figure D-15

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	77	66	143	0.02	0.28	0.06	0.80	0.36	0.32	0.18	0.25	0.25	0.30
Ponds 5 and 9	mg/kg	9	4	13	0.25	0.25	0.05	0.25	0.13	0.11	0.09	0.22	0.25	0.25

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR
-- = no data
Bkgd = Background
F = Fill
IQR = Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg = milligrams per kilogram
MSB = Marine Sediments / Bedrock
NA = Value not applicable due to frequency of detection
ND = Non-detect
Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.



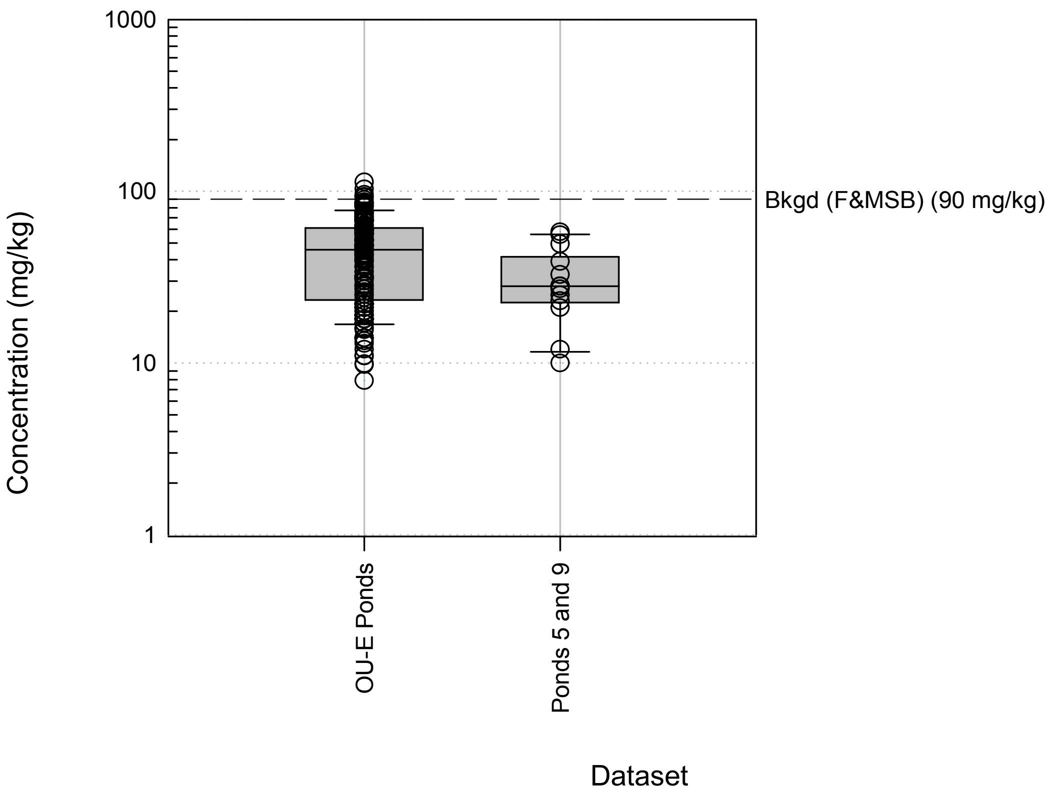
ARCADIS

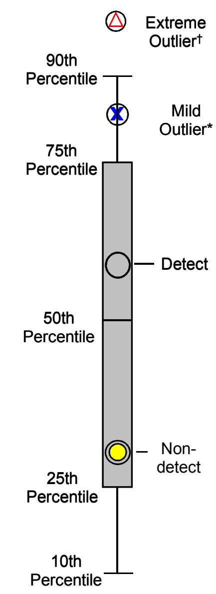
Box and Whisker Plot
Thallium
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

Figure D-16

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	76	67	143	0.19	0.28	0.04	1.4	0.37	0.25	0.28	0.21	0.25	0.27
Ponds 5 and 9	mg/kg	9	4	13	0.25	0.25	0.03	0.20	0.13	0.14	0.08	0.20	0.25	0.25

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR
-- = no data
Bkgd = Background
F = Fill
IQR = Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg = milligrams per kilogram
MSB = Marine Sediments / Bedrock
NA = Value not applicable due to frequency of detection
ND = Non-detect
Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.





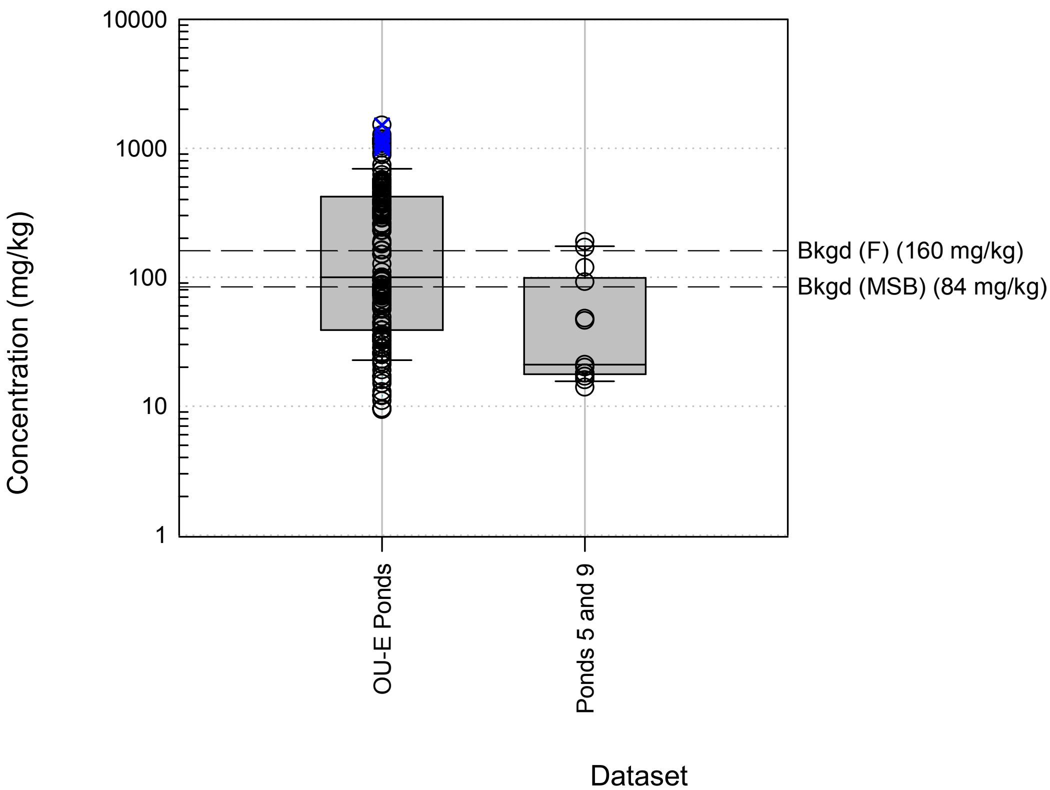
ARCADIS

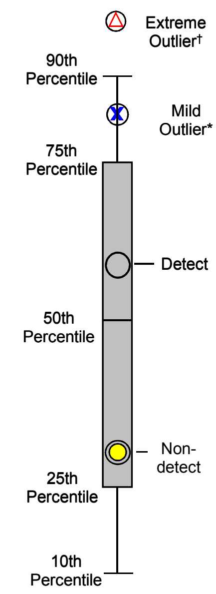
Box and Whisker Plot
Vanadium
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

Figure D-17

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	0	143	143	NA	NA	7.9	113	45.6	45.6	23.7	23.3	45.6	61.0
Ponds 5 and 9	mg/kg	0	13	13	NA	NA	10.0	58.0	31.4	28.0	15.2	22.5	28.0	41.6

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR
-- = no data
Bkgd = Background
F = Fill
IQR = Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg = milligrams per kilogram
MSB = Marine Sediments / Bedrock
NA = Value not applicable due to frequency of detection
ND = Non-detect
Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.





ARCADIS

Box and Whisker Plot
Zinc
Former Georgia-Pacific Wood Products Facility, Fort Bragg, California

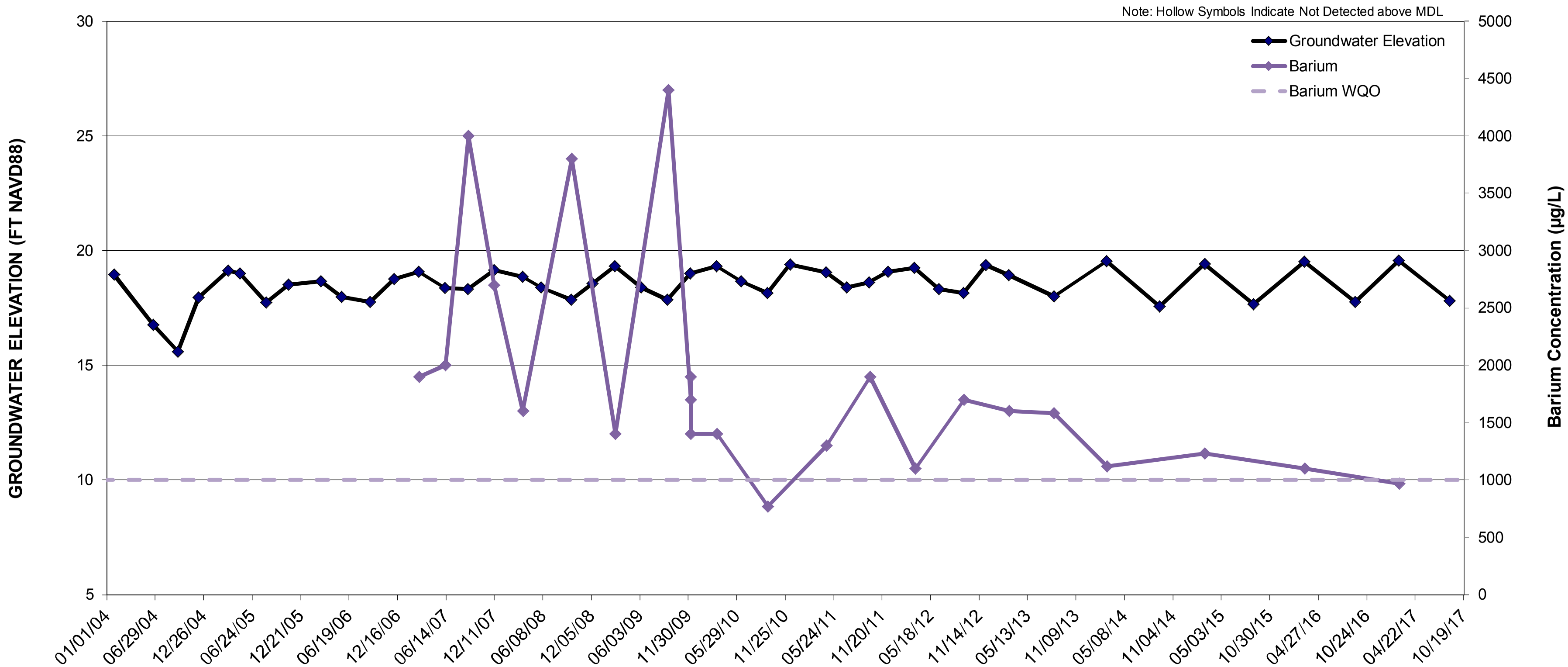
Figure D-18

Dataset	Units	Sample Size			ND Range		Detects					Percentiles (All Data)		
		NDs	Detects	Total	Min	Max	Min	Max	Mean	Median	SD	25th	50th	75th
OU-E Ponds	mg/kg	0	143	143	NA	NA	9.4	1,510	278	100.0	327	39.0	100.0	421
Ponds 5 and 9	mg/kg	0	13	13	NA	NA	14.0	189	60.6	21.0	62.0	17.8	21.0	98.8

Notes:
† Result value is < 25th percentile - 3*IQR or > 75th percentile + 3*IQR
* Result value is < 25th percentile - 1.5*IQR or > 75th percentile + 1.5*IQR
-- = no data
Bkgd = Background
F = Fill
IQR = Interquartile range equals the 3rd quartile (75th percentile) - 1st quartile (25th percentile)
mg/kg = milligrams per kilogram
MSB = Marine Sediments / Bedrock
NA = Value not applicable due to frequency of detection
ND = Non-detect
Reporting limit is used for non-detects unless otherwise noted.
Values less than 10 are reported to 2 significant figures. Values greater than 10 are reported to 3 significant figures.
OU-E Ponds dataset includes data from all OU-E ponds except Ponds 5 and 9.

Appendix D

OU-E Monitoring Well Hydrographs



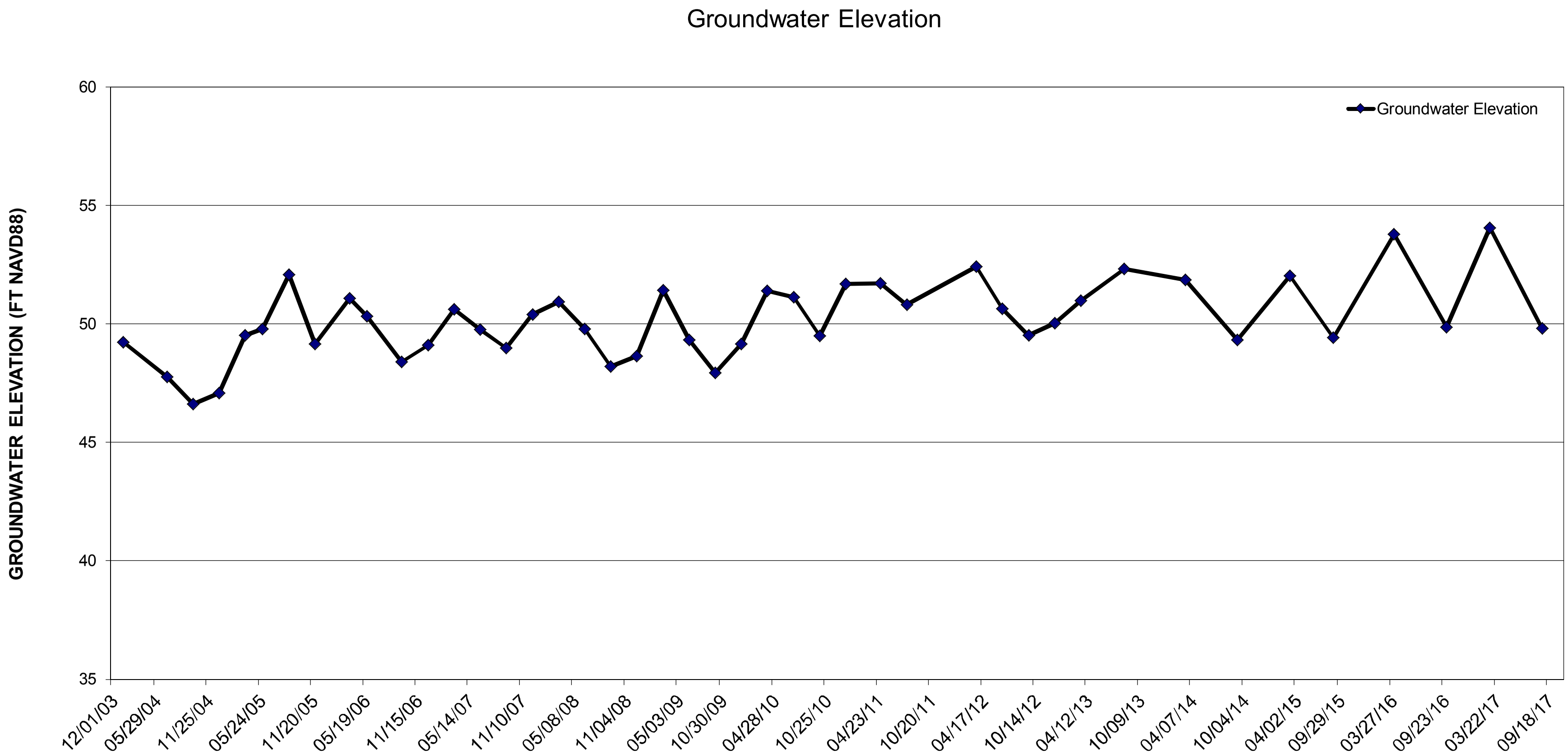
FORMER GEORGIA-PACIFIC WOOD PRODUCTS FACILITY
FORT BRAGG, CALIFORNIA

HYDROGRAPH AND CONCENTRATION TREND FOR MONITORING WELL MW-4.1

Kennedy/Jenks Consultants
Engineers & Scientists

FIGURE
D-1

ms_Appendix D - Hydrographs 2SA17.xlsx_MW-4.1_2/26/2018

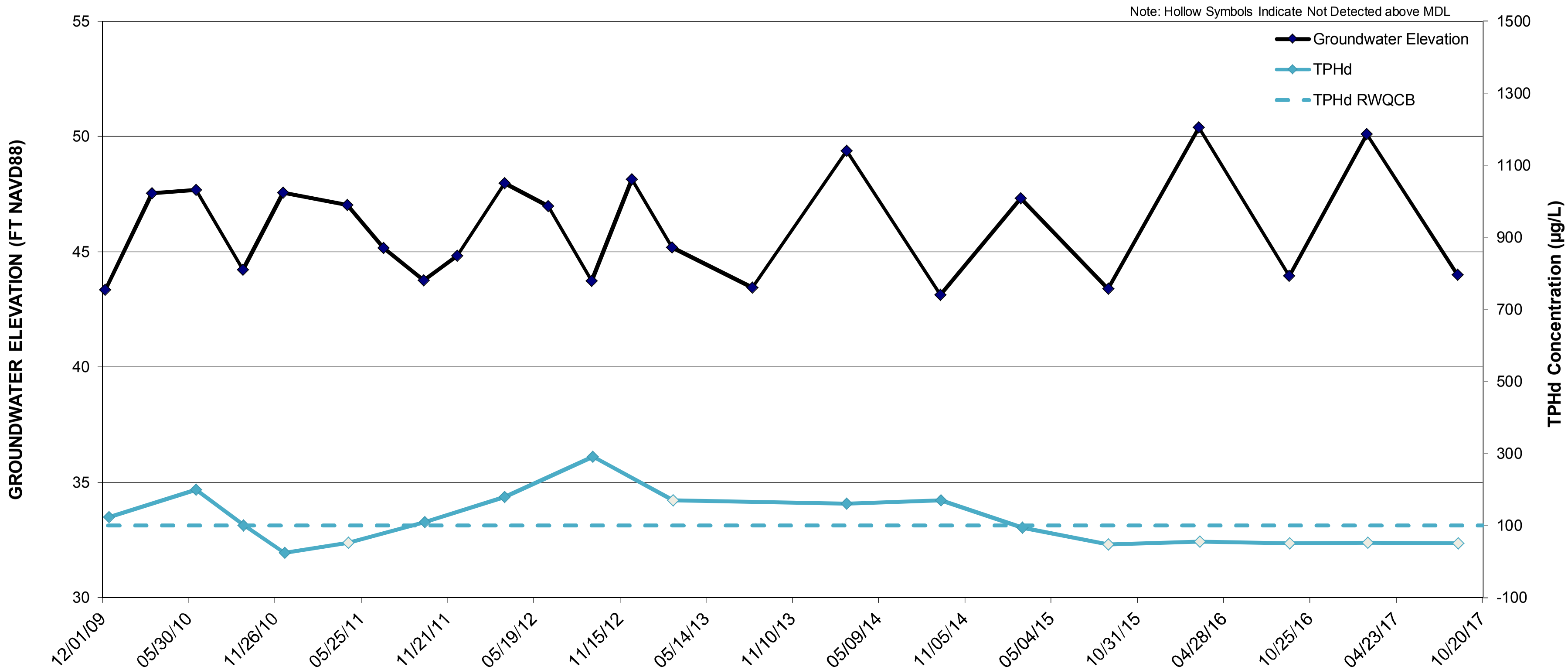


FORMER GEORGIA-PACIFIC WOOD PRODUCTS FACILITY
FORT BRAGG, CALIFORNIA

HYDROGRAPH AND CONCENTRATION TREND FOR MONITORING WELL MW-5.5

Kennedy/Jenks Consultants
Engineers & Scientists

FIGURE
D-2

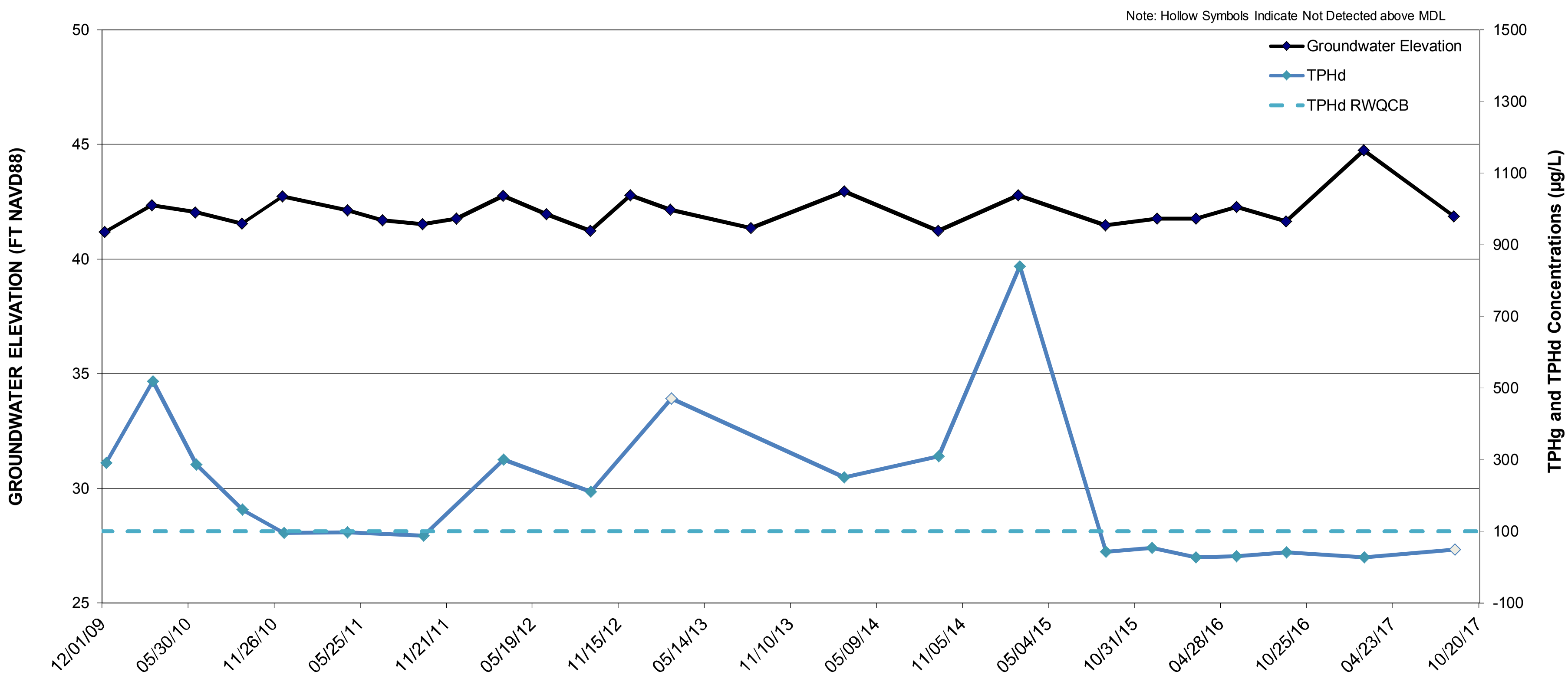


FORMER GEORGIA-PACIFIC WOOD PRODUCTS FACILITY
FORT BRAGG, CALIFORNIA

HYDROGRAPH AND CONCENTRATION TREND FOR MONITORING WELL MW-5.17

Kennedy/Jenks Consultants
Engineers & Scientists

FIGURE
D-3

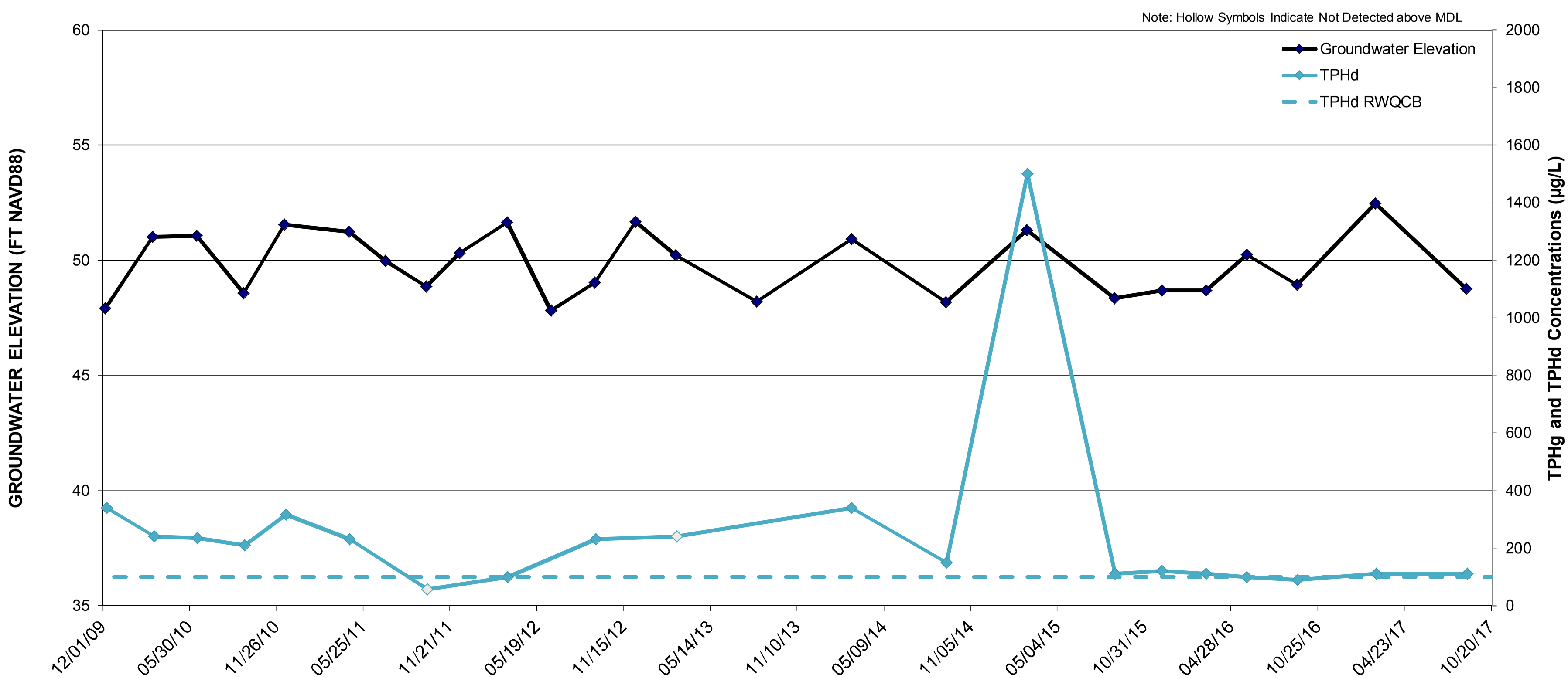


FORMER GEORGIA-PACIFIC WOOD PRODUCTS FACILITY
FORT BRAGG, CALIFORNIA

HYDROGRAPH AND CONCENTRATION TREND FOR MONITORING WELL MW-5.18

Kennedy/Jenks Consultants
Engineers & Scientists

FIGURE
D-4

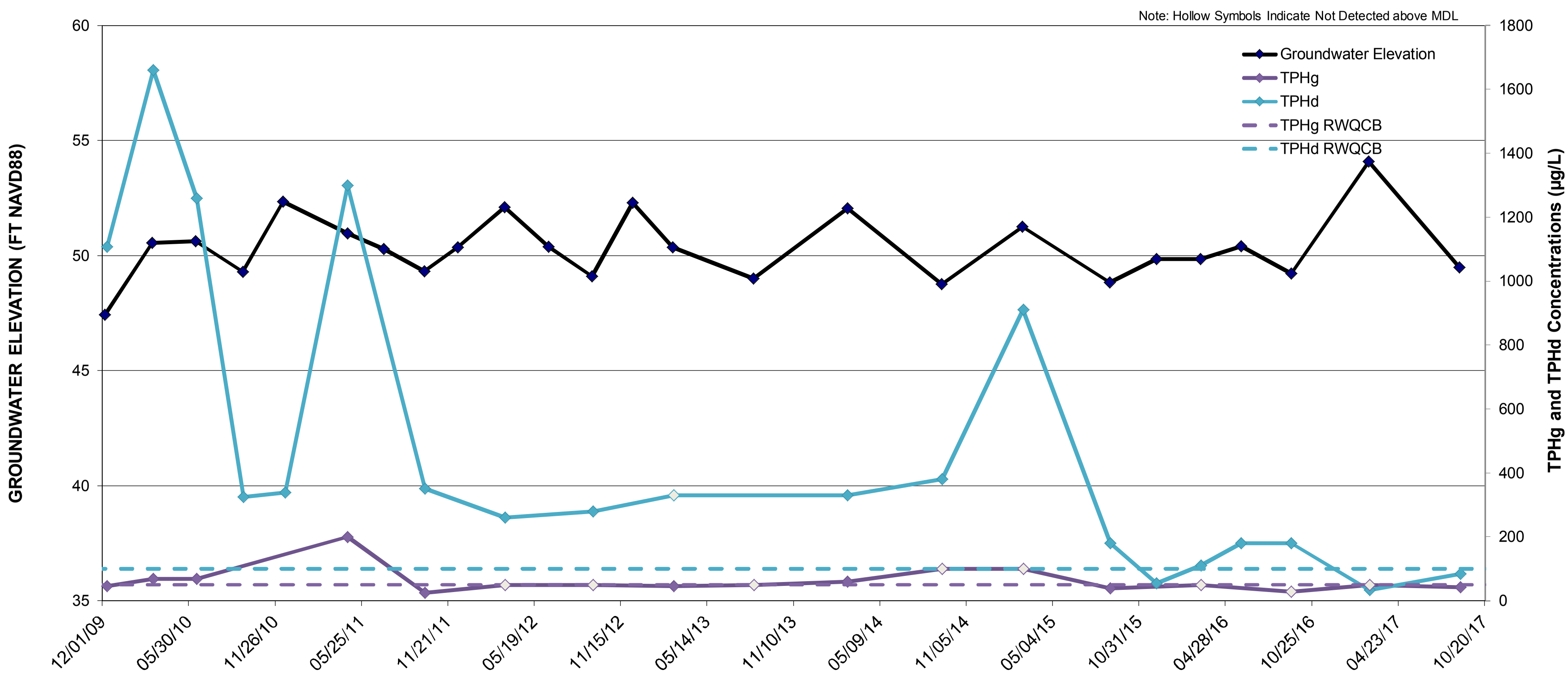


FORMER GEORGIA-PACIFIC WOOD PRODUCTS FACILITY
FORT BRAGG, CALIFORNIA

HYDROGRAPH AND CONCENTRATION TREND FOR MONITORING WELL MW-5.19

Kennedy/Jenks Consultants
Engineers & Scientists

FIGURE
D-5

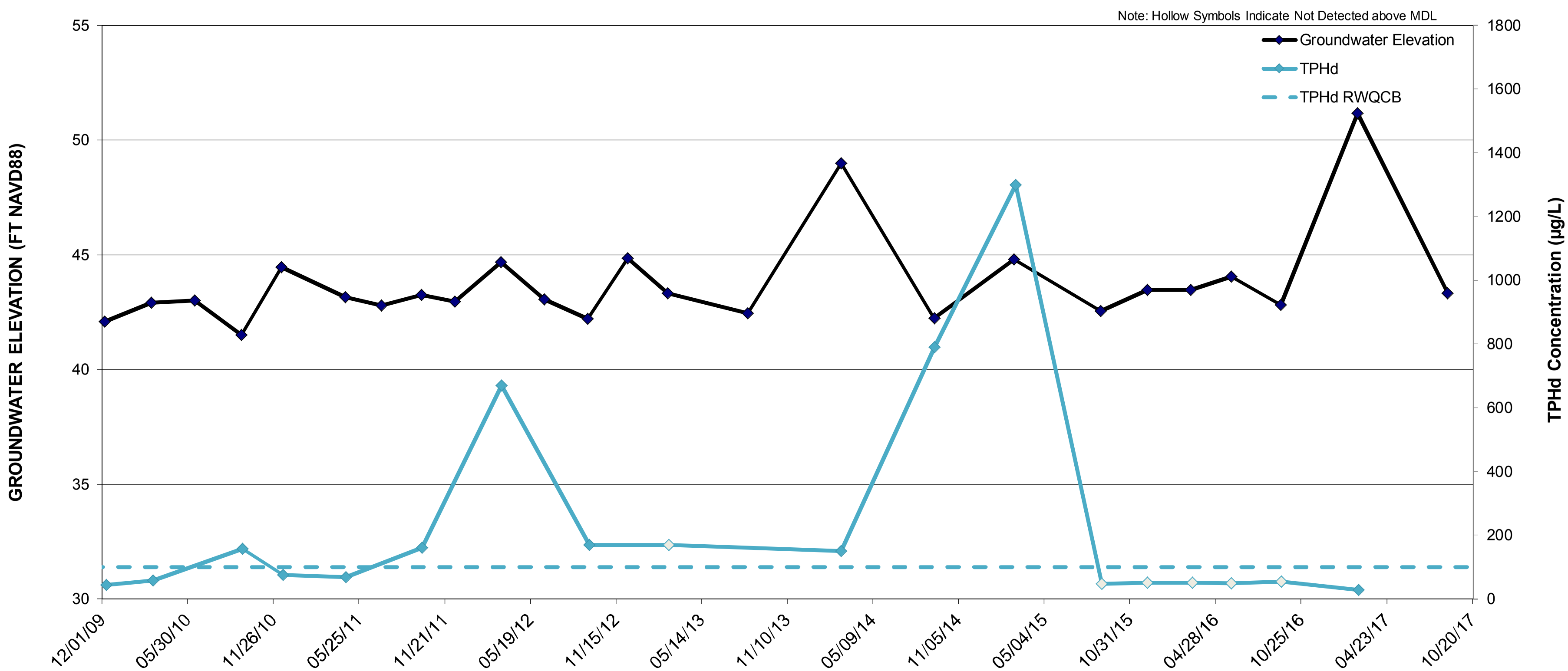


FORMER GEORGIA-PACIFIC WOOD PRODUCTS FACILITY
FORT BRAGG, CALIFORNIA

HYDROGRAPH AND CONCENTRATION TREND FOR MONITORING WELL MW-5.20

Kennedy/Jenks Consultants
Engineers & Scientists

FIGURE
D-6



FORMER GEORGIA-PACIFIC WOOD PRODUCTS FACILITY
FORT BRAGG, CALIFORNIA

HYDROGRAPH AND CONCENTRATION TREND FOR MONITORING WELL MW-5.21

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FIGURE
D-7

ms_Appendix D - Hydrographs 2SA17.xlsx_MW-5.21_2/26/2018