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Subject:

Revised Baseline Human Health and Ecological Risk Assessment (BHHERA)
Work Plan – Operable Unit E (OU-E) Addendum In Response to DTSC
Comments dated January 11, 2013 and January 30, 2013

Dear Mr. Lanphar:

On behalf of Georgia-Pacific, LLC (Georgia-Pacific), ARCADIS U.S., Inc (ARCADIS) is submitting this revised Baseline Human Health and Ecological Risk Assessment (BHHERA) Work Plan – Operable Unit E (OU-E) Addendum in response to comments from the Department of Toxic Substances Control (DTSC) provided in letters dated January 11, 2012 and January 30, 2012. The revised OU-E BHHERA Work Plan Addendum addresses comments in both of the above referenced letters and discussed during a meeting between DTSC and Georgia-Pacific representatives on February 12, 2013.

Additional information regarding pore water sampling was provided by email and discussed in the February 12, 2013 meeting. The revised work plan contains the requested information and SOPs for sediment and pore water sampling. Based on discussion in the meeting we anticipate moving forward with sampling in March following DTSC approval of the field work.

As discussed in the February 12, 2013 meeting, the OU-E BHHERA Work Plan Addendum proposes collection of samples for arsenic speciation which will be used to support selection of an arsenic relative bioavailability (RBA) value. Following the receipt of arsenic speciation data and following DTSC evaluation of EPA's recently published guidance on default arsenic RBA, Georgia-Pacific will meet with DTSC to discuss RBA values prior to submittal of the OUE BHHERA.

Further, consistent with discussion in the February 12, 2013 meeting, the revised work plan indicates a range of exposure frequencies will be evaluated and discussed in the BHHERA. The work plan also response to comments related to area use factors for aquatic and terrestrial receptors.

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ENVIRONMENT

Date:
February 15, 2013

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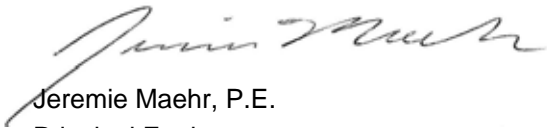
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B0066142.2012

Mr. Thomas Lanphar
February 15, 2013

Please contact me at 415.432.6918 if you have questions regarding the revised
OU-E BHHERA Work Plan Addendum.

Sincerely,

ARCADIS

A handwritten signature in black ink, appearing to read "Jeremie Maehr".

Jeremie Maehr, P.E.
Principal Engineer

Copies:

Dave Massengill, Georgia Pacific LLC.
Craig Hunt Regional Water Quality Control Board
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**Baseline Human Health and
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Plan – Operable Unit E Addendum**

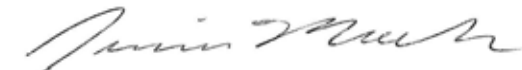
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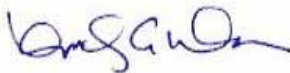
October 2012


Revised December 17, 2012

Revised February 15, 2013

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Baseline Human Health and Ecological Risk Assessment Work Plan – Operable Unit E Addendum

Former Georgia-Pacific Wood Products Facility

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B0066142

Date:
October 2012
Revised December 17, 2012
Revised February 15, 2013

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Acronyms and Abbreviations

AOI	Area of Interest
AMU	atomic mass unit
ARCADIS	ARCADIS U.S., Inc.
BHHERA	Baseline Human Health and Ecological Risk Assessment
CSM	conceptual site model
DQOs	data quality objectives
DTSC	Department of Toxic Substances Control
EMPA	electron microprobe analysis
EqP	equilibrium partitioning
ft bss	feet below sediment surface
Georgia-Pacific	Georgia-Pacific, LLC
ICP-AES	inductively coupled plasma-atomic emission spectroscopy
LOAEL	lowest observed adverse effect level
NOAEL	no observed adverse effect level
OU	operable unit
Work Plan	Operable Unit E Baseline Human Health and Ecological Risk Assessment Work Plan
PAHs	polycyclic aromatic hydrocarbons
QAPP	Quality Assurance Project Plan
RAWP	Risk Assessment Work Plan
RBA	relative bioavailability
RI	Remedial Investigation
site	Former Georgia-Pacific Wood Products Facility
SOP	standard operating procedure
SM	standard method
TOC	total organic carbon
TRVs	toxicity reference values

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**BHHERA Work Plan –
OU-E Addendum**

Former Georgia-Pacific Wood
Products Facility

USEPA

United States Environmental Protection Agency

1. Introduction

On behalf of Georgia-Pacific, LLC (Georgia-Pacific), ARCADIS U.S., Inc. (ARCADIS) prepared this Baseline Human Health and Ecological Risk Assessment Work Plan Addendum for Operable Unit E (Work Plan) for the Former Georgia-Pacific Wood Products Facility located at 90 West Redwood Avenue, Fort Bragg, Mendocino County, California (site, Figure 1). The Work Plan is an addendum to the *Site-Wide Risk Assessment Work Plan, Former Georgia-Pacific Wood Products Facility, Fort Bragg, California* (ARCADIS BBL 2008) (Site-Wide RAWP), and outlines the approach to evaluate potential baseline risks to human and ecological receptors specific to Operable Unit E (OU-E). OU-E is one of five operable units on the site, and consists of approximately 27 terrestrial acres and a total of 11 acres of seasonal wetland and man-made ponds (i.e., Ponds 1 through 9 and the North Pond). The boundaries of OU-E are presented on Figure 2.

This Work Plan also includes data collection activities to refine potential risks reported for the Riparian Area of Interest (AOI) in the OU-C/OU-D Remedial Investigation Report (ARCADIS 2011).

1.1 Objective

This Work Plan describes data collection and sampling and analysis activities that will be conducted to support the forthcoming Baseline Human Health and Ecological Risk Assessment (BHHERA). As requested by the Department of Toxic Substances Control (DTSC), this Work Plan also references Agency-approved documents that provide methodologies for the upcoming BHHERA. The proposed methodologies are consistent with those presented in the site documents listed below and are further discussed in the following sections.

- Site-Wide RAWP.
- *Final Operable Unit A (OU-A) Remedial Action Plan and Feasibility Study, Former Georgia-Pacific Wood Products Facility, Fort Bragg, California* (ARCADIS 2008).
- *Technical Memorandum – Risk Assessment Approach for Operable Unit E* (ARCADIS 2010).
- *Remedial Investigation Report, Operable Units C and D, Former Georgia-Pacific Wood Products Facility, Fort Bragg California* (ARCADIS 2011).

The remainder of this Work Plan is organized as follows:

- **Section 2, Proposed Data Collection**, summarizes data collection and analysis methods for evaluating the bioaccessibility and bioavailability of selected constituents in OU-E;

- **Section 3, Human Health Risk Assessment**, describes the methods to be used for the exposure assessment of potential human receptors;
- **Section 4, Ecological Risk Assessment**, describes the methods to be used for the exposure and toxicity assessments of the baseline ecological risk assessment;
- **Section 5, Schedule**, recommends a schedule for implementing the proposed data collection; and
- **Section 6, References**, provides a list of references cited within this report.

2. Proposed Data Collection

Based on information presented in the Final OU-E Remedial Investigation (RI) Report (ARCADIS 2013), additional data is required to address the following two key risk questions:

- What is the bioaccessible fraction of arsenic in OU-E sediment for potential human receptors, and does exposure to the bioaccessible fraction result in potentially unacceptable risk?
- Do metals and polycyclic aromatic hydrocarbons (PAHs) in OU-E sediment partition to porewater at sufficient concentrations to result in potentially unacceptable risk to benthic organism communities?

The following section outlines proposed data collection activities intended to fill data gaps, and describes how these data will be evaluated to answer the identified risk questions.

Data quality objectives (DQOs) for the proposed investigation were developed in accordance with the United States Environmental Protection Agency (USEPA) seven-step DQO process guidelines (USEPA 2000), and are presented in Table 1, along with a summary of Step 1 through Step 7 of the DQO process.

2.1 Relative Bioavailability of Arsenic for Potential Human Receptors

The OU-E RI (ARCADIS 2013) identified arsenic in sediment exceeding human health risk-based screening levels. Currently, toxicity criteria for estimating health effects of arsenic are based on humans exposed to arsenic dissolved in water. Because arsenic at the site may be bound to soil, sediment, and rock, it is necessary to evaluate an appropriate relative bioavailability (RBA), the ratio of uptake of soil-bound arsenic to arsenic dissolved in water, to assess human health risks associated with soil/sediment exposure.

The bioavailability of arsenic is largely controlled by arsenic speciation and other geochemical conditions. Therefore, additional arsenic speciation data will be collected in OU-E, as summarized in Section 2.1.2. Geochemical results will be reviewed to evaluate RBA values appropriate for use in the BHHERA and the potential benefits of additional site specific studies. Specific information regarding the RBA selected for use in the BHHERA and the basis of this selection will be coordinated with DTSC prior to submittal of the BHHERA.

2.1.1 Sample Collection Methods

The first decision question (Table 1, Column 2) will be investigated by collecting surface sediment samples to a depth of 0.5 feet below sediment surface (ft bss) at 13 locations throughout the study area, as listed in the proposed sample matrix (Table 2) and presented on Figures 3 through 5. Sample locations were chosen biased towards the highest arsenic concentrations that exceeded the site-specific background (ARCADIS

2013), as identified in previous sampling events. Additionally, sample locations were selected to provide spatial coverage in each pond and to bias sample locations towards portions of the ponds that would be most accessible to humans (e.g., pond edges).

At each sample location, field personnel will collect a sediment sample from the 0.0 to 0.5 ft bss depth interval using the appropriate method for the physical conditions per the “Sediment Sampling with Dewatering” standard operating procedure (SOP) in the Quality Assurance Project Plan (QAPP, ARCADIS BBL 2007).

Filled sample containers will be placed on ice in preparation for shipment. Samples will be shipped to the laboratories listed in the proposed sample matrix (Table 2).

Field personnel will photo-document sample collection.

2.1.2 Analytical Methods

Data to address the first decision question (Table 1, Column 2) will be obtained using the laboratory analyses listed below.

- Electron microprobe analysis (EMPA) for arsenic speciation, following the standard operating procedure of the Laboratory for Environmental and Geological Studies at the University of Colorado, Boulder.
- Inductively coupled plasma atomic emission spectroscopy (ICP-AES) analysis for total arsenic, following USEPA Method 6010.

2.2 Bioavailability of Metals and Polycyclic Aromatic Hydrocarbons

The OU-E RI (ARCADIS 2013) identified metals and PAHs exceeding conservative sediment screening levels for protection of benthic organism communities in the ponds. Similar exceedances for metals and PAHs were also observed in the riparian area of OU-D (undeveloped, wooded land with a wetland ditch located along the eastern boundary of Parcel 7; refer to Figures 2 and 6). The direct application of screening levels does not consider partitioning of metals or PAHs from sediment to porewater, with porewater being the primary medium of exposure. Therefore, risk characterization based on generic screening levels without consideration of site-specific conditions that affect bioavailability may overestimate risks to benthic organisms.

To address this uncertainty, field personnel will collect porewater samples for laboratory analysis of metals, major cations, major anions, and alkalinity as well as sediment samples for laboratory analysis of alkylated PAHs in sediment and porewater, and abiotic factors that influence bioavailability (e.g., total organic carbon

[TOC], black carbon, and pH). The sediment PAH, organic carbon, and black carbon data will be used to assess bioavailability of PAHs to benthic organisms following equilibrium partitioning (EqP) theory presented in USEPA (2003) guidance and current literature (Accardi-Dey and Gschwend 2002, Koelmans et al. 2005, Hauck et al. 2007).

Details of the proposed sampling and analysis are provided below.

2.2.1 Sample Collection Methods

The second decision question (Table 1, Column 2) will be investigated by collecting both porewater and surface sediment (i.e., 0.0-0.5 ft bss), as listed in the proposed sample matrices (Tables 2 and 3) and presented on Figures 3 through 6. Sample locations were chosen to include a range of concentrations that exceeded the threshold effects concentrations (MacDonald et al. 2000) and the maximum detections of metals and PAHs observed in previous sampling events. Additionally, sample locations were selected to provide spatial coverage in the ponds.

Porewater samples for evaluation of metals bioavailability will be collected using an *in-situ* dialysis membrane sampler based on methods described by Carignan et al. (1985) and Vroblewski et al. (2002). Information regarding the sampling procedure is included in the attached Porewater Sampling Using an *In-situ* Dialysis Membrane Sampling Apparatus Standard Operating Procedure (Appendix A).

Field personnel will implement sampling using the following technical specifications. Literature references used as the basis for selection of the technical specifications are cited below.

- Membrane type: pretreated tubular acetate cellulose dialysis membrane (Interstate Technical & Regulatory Council 2006, Vroblewski et al. 2002)
- Pore size: nominal molecular weight cutoff of 8,000 atomic mass units (amu) (Vroblewski et al. 2002).
- Deployment time: minimum of 12 days to allow for equilibration of constituent concentrations between the sampling device and sediment porewater and a maximum of 14 days to minimize potential for degradation of the dialysis membrane (Carignan et al 1985, Brandl and Hanselmann 1991, Vroblewski et al. 2002)
- Sampling device: acetate cellulose dialysis membrane around internal rigid support inside an external rigid sheath to protect membrane (modified from Vroblewski et al. 2002).
- Sampling medium: dialysis membrane filled with deoxygenated, deionized water (Carignan et al. 1985).

- Sample retrieval: sampling medium transferred directly into a laboratory supplied container and preserved, as appropriate.

Sediment samples for evaluation of PAH bioavailability, arsenic speciation and general chemistry will be collected directly adjacent to the area of porewater collection prior to porewater sampler deployment to avoid disturbance of the surface sediment that may occur during the porewater sampler deployment/retrieval process.

Sediment sample collection methods will be consistent with Section 2.1.1.

2.2.2 Analytical Methods

Data to address the second decision question (Table 1, Column 2) will be obtained using the laboratory analyses of porewater and sediment samples listed below.

Dialysis membrane sampling apparatus porewater analyses:

- Total concentrations of the following constituents will be measured using USEPA Method 6020:
 - Antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, selenium, silver, sodium, thallium, vanadium, and zinc.
- Total mercury will be measured using USEPA method 7470.
- Total concentrations of the following constituents will be measuring using USEPA Method 6010
 - Calcium, iron, magnesium, manganese, potassium, and sodium.
- Hardness will be calculated using concentrations of calcium and magnesium measured above.
- Concentrations of chloride and sulfate by USEPA Method 300.0.
- Concentration of sulfide by USEPA 9030M.
- Alkalinity by Standard method (SM) 2320B.
- Dissolved organic carbon (DOC) by SM 5310C.

Bulk sediment analyses:

- Bulk sediments analyzed for porewater alkylated PAH concentrations using a solid-phase microextraction standard operating procedure modified from ASTM D7363-07 (TestAmerica 2012). The specific list of PAHs to be analyzed is presented in Table 4.
- Bulk sediments analyzed for alkylated PAHs using USEPA Method 8270C SIM. The specific list of PAHs to be analyzed is consistent with USEPA (2003) equilibrium partitioning guidance, and is presented in Table 4.
- TOC using the Lloyd Kahn Method.
- Black carbon using a modified version of the Lloyd Kahn Method.
- Grain size using ASTM International Method D422.
- pH using USEPA Method 9040B.
- Oxidation/reduction potential, temperature, pH and dissolved oxygen using a Horiba D-22 or similar field probe following SOP methods present in the QAPP (ARCADIS BBL 2007).
- EMPA and ICP-AES analysis described in Section 2.1.2.

Results obtained from the analytical methods described above will be used to measure concentrations of constituents in OU-E sediment and porewater, and will be used to develop the following:

- information regarding the geochemical state of OU-E sediment to assess the bioavailability of PAHs to benthic organisms using equilibrium partitioning theory (Accardi-Dey and Gschwend 2002, USEPA 2003, Koelmans et al. 2005, Hauck et al. 2007) and the mineralogy of OU-E sediment;
- information regarding water chemistry (pH, alkalinity, and concentrations of DOC and major inorganic cations and anions) of OU-E sediment porewater to assess the toxicity of six of the cationic metals (i.e., Ag, Cd, Cu, Ni, Pb and Zn) to benthic organisms using the biotic ligand model (Meyer et al. 1999, Di Toro et al. 2001, Paquin et al. 2002); and
- comparisons of the remaining metals concentrations in porewater to ecological screening levels for aquatic life.

3. Human Health Risk Assessment

The proposed OU-E specific approach to the human health risk assessment is based on a conceptual site model (CSM) for constituent sources, exposure pathways, and receptors. The CSMs illustrating potential sources and transport pathways were provided in previous documents and have been updated, as described in the following sections. Figures 7 and 8 present the terrestrial area and aquatic area (i.e., ponds) exposure evaluation, respectively. Methods for the exposure assessment (e.g., exposure point concentration estimation, exposure estimates, and lead exposure evaluation) are consistent with the Site-Wide RAWP (ARCADIS BBL 2008). Differences regarding exposure assumptions are discussed below. Toxicity values will be selected in accordance with the hierarchy presented in the Site-Wide RAWP.

Potential human receptors were modified from those listed in the Site-Wide RAWP to correspond with the OU-E CSM. Potential human receptors for the site are consistent with the human health CSM, as presented in the Site-Wide RAWP with the addition of a commercial/industrial worker, to account for potential future use of OU-E as a commercial property. Potential human receptors in terrestrial portions of OU-E will include commercial/industrial workers, maintenance/utility/trench workers, construction workers, and recreators (including occasional visitors [i.e., passive recreators] and regular visitors to the site [i.e., frequent recreators]). Exposure parameters to estimate potential exposure to constituents in terrestrial soil are consistent with those presented in the Site-Wide RAWP.

In aquatic areas, occasional visitors (i.e., passive recreators) will be evaluated as potential receptors. Human receptors are unlikely to be exposed to the aquatic portions of OU-E because the current and future wetlands have environmentally sensitive habitat area protection that restricts visitors from entering these areas (e.g., placement of boardwalks/trails outside of sensitive habitat areas, fencing, and/or signage). Despite these provisions, a passive recreator will be considered a potential human receptor in the aquatic portions of OU-E. This scenario conservatively assumes that recreators may ignore such provisions and occasionally enter these aquatic areas at a frequency of 12 days per year (once per month), resulting in potential exposure to sediment and surface water. An alternate passive recreator scenario will also be presented for the aquatic portions of OU-E using an exposure frequency of 50 days per year. This alternate scenario conservatively assumes that the passive recreator receptors will be exposed to the aquatic portions of OU-E at the same frequency as the passive recreator in the terrestrial portions of OU-E.

4. Ecological Risk Assessment

The proposed OU-E specific approach to the ecological risk assessment is based on constituent sources, exposure pathways, and receptors identified in the upland and aquatic CSMs presented on Figures 7 and Figure 8, respectively. Methods for the exposure assessment (e.g., exposure point concentration estimation, daily dose estimates, and effects assessment) are consistent with the Site-Wide RAWP (ARCADIS 2008). Differences regarding exposure assumptions are discussed below. Representative receptors are consistent with the Site-Wide RAWP with the exception of the great blue heron, which will not be included as a potential receptor. ARCADIS excluded the great blue heron because its diet consists primarily of fish, and the presence of fish in site ponds is likely limited. Ecological exposure parameters are consistent with the Site-Wide RAWP unless otherwise noted below. Changes to exposure parameters from the Site-Wide RAWP are as follows:

- Killdeer home range was revised to reflect a more accurate measure, using the foraging distance from a central point as the radius rather than the diameter;
- American kestrel diet was revised to more accurately reflect dietary composition (i.e., 33 percent invertebrate, 67 percent small mammal/bird; USEPA 1993), rather than conservatively assuming 100 percent consumption of small mammals;
- Mallard home range was revised to accurately reflect the units (hectares) in the original reference;
- Virginia rail diet was revised to more accurately reflect dietary composition (i.e., 15 percent vegetation and 85 percent invertebrates), rather than assuming 100 percent consumption of invertebrates (Conway 1995); and
- Raccoon diet was revised to assume that invertebrate consumption would be substituted for fish dietary composition cited in literature due to the paucity of fish in aquatic areas of OU-E.

Area use factors for upper trophic level receptors will be based on use of the entire area of appropriate habitat (i.e., aquatic or terrestrial) in the OU-E AOCs, and assume an acreage of 10 acres of aquatic habitat and 11.1 acres of terrestrial habitat as depicted on Figure 2. The BHHERA will also present a sensitivity analysis of potential hot-spot exposure for aquatic upper trophic level receptors by evaluating each pond AOC separately using area use factors based on the respective pond AOC acreages.

The selection hierarchy for no-observed adverse effect level (NOAEL) toxicity reference values (TRVs) for the effects assessment is consistent with the Site-Wide RAWP. The selection hierarchy for lowest observed adverse effect level (LOAEL) TRVs is consistent with methods updated in the Remedial Investigation Report

for Operable Units C and D (ARCADIS 2011). Table 7 presents selected TRVs and the source of each value.

5. Schedule

To conservatively capture potential bioavailability of divalent metals, USEPA (2005) recommends that sediment be collected when microbial activity is low during the year (e.g., November to early May). Sampling during periods of low microbial activity in sediment conservatively estimates divalent metals bioavailability, because acid volatile sulfide concentrations, which are a significant partitioning phase for divalent metals, are typically higher in sediment during periods when sulfate reducing microbes, which reduce sulfate to sulfide, are most active. ARCADIS will mobilize field personnel to collect data proposed in this Work Plan within 30 days following approval by the regulatory agencies and, to the extent possible, within the time period when sample collection would conservatively estimate bioavailability of divalent metals (e.g., November to May).

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Tables

Table 1
Data Quality Objectives for Bioavailability of Metals and PAHs
Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operational Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Column 1	Column 2 ("Decision Questions")	Column 3	Column 4	Column 5	Column 6	Column 7
State the Problem	Identify the Decisions	Inputs to the Decisions	Define Study Boundaries of OUE	Decision Rules	Specify Limits on Decision Errors	Optimize the Sampling Design
<p>The OU-E RI (ARCADIS 2013) identified arsenic in sediment exceeding human health risk-based screening levels. Because arsenic at the site may be bound to soil, sediment, and rock, it is necessary to evaluate an appropriate relative bioavailability (RBA), the ratio of uptake of soil-bound arsenic to arsenic dissolved in water, to assess human health risks associated with soil/sediment exposure. The application of generic arsenic screening levels and use of 100% RBA in exposure modeling may overestimate potential risk without evaluation of an appropriate RBA.</p> <p>The OU-E RI (ARCADIS 2013) identified metals and polycyclic aromatic hydrocarbons (PAHs) exceeding conservative sediment screening levels for protection of benthic organism communities in the ponds. Similar exceedances for metals and PAHs were also observed in the riparian area of OU-D (undeveloped, wooded land with a seasonal wetland ditch located along the eastern boundary of Parcel 7; refer to Figures 2 and 6). The direct application of screening levels does not consider the partitioning of metals or PAHs from sediment to porewater, with porewater being the primary medium of exposure. Therefore, risk characterization based on generic screening levels without consideration of site-specific</p>	<ol style="list-style-type: none"> 1. What is an appropriate RBA for arsenic in OU-E sediment for potential human receptors, and does exposure to this bioaccessible fraction result in potentially unacceptable risk? 2. Do metals and PAHs in OU-E sediment partition to porewater at sufficient concentrations to result in potentially unacceptable risk to benthic organism communities? 	<ol style="list-style-type: none"> 1. Concentrations of PAHs (including alkylated homologs), organic carbon, black carbon, and arsenic in sediment of the study area (Decision Questions 1 and 2). 2. Concentrations of metals and PAHs in porewater of the study area (Decision Question 2). 3. Results of the biotic ligand model (Meyer et al. 1999, Di Toro et al. 2001, Paquin et al. 2002). 4. Geochemical information collected in the study area (Decision Questions 1 and 2). 5. Information regarding arsenic speciation collected in study area sediment (Decision Questions 1 and 2). 6. Equilibrium partitioning (EqP) modeling for PAHs (Accardi-Dey and Gschwend 2002, United States Environmental Protection Agency (USEPA) 2003, Koelmans et al. 2005, Hauck et al. 2007) (Decision Question 2). 	<p>Specific physical boundaries are shown on Figures 1 and 2 with specific sample locations indicated on Figures 3 through 6.</p>	<ul style="list-style-type: none"> • If concentrations of arsenic in site sediment are sufficiently bioaccessible to result in potentially unacceptable risk to human receptors, then further evaluation and/or remedial action will be proposed (Decision Question 1). • If concentrations of metals or PAHs in site porewater are at sufficient concentrations to result in potentially unacceptable risk, then further evaluation and/or remedial action will be proposed (Decision Question 2). • If in the sediment, the sum of PAH equilibrium sediment benchmark toxic units is greater than or equal to one, indicating potentially unacceptable risk to benthic organisms in the study area, then further evaluation and/or remedial action for PAHs will be proposed (Decision Question 2). • Since PAH porewater analyses do not address all the alkylated PAHs included in the USEPA (2003) EqP model, results from the porewater analysis and the EqP modeling will be evaluated in a weight of evidence approach to assess if further evaluation and/or remedial action is an appropriate decision. 	<p>Potential sources of decision errors include:</p> <ul style="list-style-type: none"> • Uncertainties associated with estimating bioaccessibility of arsenic in sediment. • Uncertainties associated with in-situ porewater sampling using an acetate cellulose dialysis membrane. • Uncertainties associated with chemical analysis of metals and PAHs in porewater. • Uncertainties associated with chemical analysis of PAHs in sediments. • Uncertainties associated with equilibrium partitioning modeling to predict dissolved porewater concentrations. While PAH partitioning is controlled primarily by sediment carbon fractions, other partitioning phases (e.g., partitioning to colloids) can affect PAH bioavailability. However, equilibrium partition model results are generally conservative. • Methods to control the decision errors are listed below: <ul style="list-style-type: none"> • Minimize sediment disturbance during sampling. Minimize oxygenation of the dialysis membrane porewater sampler (DMPS) during 	<p>Sample locations will be selected by the following:</p> <ul style="list-style-type: none"> • Identify constituents above threshold effects concentrations (TECs) (MacDonald et al. 2000). • Select sample locations that include a range of values for constituents above TECs. • Modify selected locations to include maximum detected concentrations of constituents above TECs and to get spatial coverage in ponds. • Select analyses based on need to address TEC exceedance not met with current data (e.g., potential risk from PAHs using equilibrium partitioning for 13 of the United States Environmental Protection Agency's (USEPA) Priority Pollutant List PAHs could not be ruled out at 99% certainty).

Table 1
Data Quality Objectives for Bioavailability of Metals and PAHs
Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operational Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Column 1	Column 2 ("Decision Questions")	Column 3	Column 4	Column 5	Column 6	Column 7
State the Problem	Identify the Decisions	Inputs to the Decisions	Define Study Boundaries of OUE	Decision Rules	Specify Limits on Decision Errors	Optimize the Sampling Design
<p>conditions that affect bioavailability or measurement of the exposure medium (i.e., porewater) may overestimate risks to benthic organisms.</p>					<p>deployment and retrieval.</p> <ul style="list-style-type: none"> • Use an optimal length of time (12 to 14 days) for the equilibration phase of the porewater collection that will allow for equilibration of constituent concentrations between sediment porewater and the DMPS and prevent degradation of the dialysis membrane. • Assess implementation of appropriate field and laboratory analytical methods through collection of quality assurance/quality control samples. • Use appropriate methods to estimate the percent bioaccessible arsenic concentration. • Collect sufficient data from the study area to characterize sediment geochemistry, fraction organic carbon and black carbon, and alkylated PAH concentrations. • Analyze appropriate PAHs for equilibrium partitioning modeling as presented in Table 3. 	

Table 1
Data Quality Objectives for Bioavailability of Metals and PAHs
Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operational Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

References:

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**Table 2
Proposed Sediment Sample Matrix**

**Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California**

Sample Identification and Analysis Method	Porewater PAHs ¹	Sediment PAHs ²	Total Organic Carbon ²	Black Carbon ²	Grain Size ²	pH ²	Oxidation/Reduction Potential, Dissolved Oxygen, pH and Temperature	EMPA ³	Total As ²	Sample Volume
	<i>TestAmerica SOP No. Knox-ID-0018</i>	<i>USEPA 8270C SIM</i>	<i>Lloyd Kahn Method</i>	<i>Modified Lloyd Kahn Method</i>	<i>ASTM D422</i>	<i>USEPA SW 9040B</i>	<i>Field measurement</i>	<i>UC-Boulder LEGS method</i>	<i>USEPA 6010</i>	
Ponds 1-4										
Pond1-01			X		X	X	X	X	X	32 oz glass jar for TestAmerica 8 oz jar for LEGS
Pond1-02			X		X	X	X	X	X	32 oz glass jar for TestAmerica 8 oz jar for LEGS
Pond2-01	X	X	X	X	X	X	X	X	X	8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica 8 oz jar for LEGS
Pond2-02	X	X	X	X	X	X	X	X	X	8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica 8 oz jar for LEGS
DP-7.13	X	X	X	X	X	X	X			8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica
Pond3-04			X		X	X	X	X	X	32 oz glass jar for TestAmerica 8 oz jar for LEGS
Pond3-06			X		X	X	X	X	X	32 oz glass jar for TestAmerica 8 oz jar for LEGS
Pond3-07			X		X	X	X	X	X	32 oz glass jar for TestAmerica 8 oz jar for LEGS
Pond3-08			X		X	X	X			32 oz. glass jar for TestAmerica
Pond3-09			X		X	X	X			32 oz. glass jar for TestAmerica

**Table 2
Proposed Sediment Sample Matrix**

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Sample Identification and Analysis Method	Porewater PAHs ¹	Sediment PAHs ²	Total Organic Carbon ²	Black Carbon ²	Grain Size ²	pH ²	Oxidation/Reduction Potential, Dissolved Oxygen, pH and Temperature	EMPA ³	Total As ²	Sample Volume
	<i>TestAmerica SOP No. Knox-ID-0018</i>	<i>USEPA 8270C SIM</i>	<i>Lloyd Kahn Method</i>	<i>Modified Lloyd Kahn Method</i>	<i>ASTM D422</i>	<i>USEPA SW 9040B</i>	<i>Field measurement</i>	<i>UC-Boulder LEGS method</i>	<i>USEPA 6010</i>	
Pond 5										
Pond5-02			X		X	X	X			32 oz. glass jar for TestAmerica
Pond5-03			X		X	X	X			32 oz. glass jar for TestAmerica
Ponds 6, 7 and North Pond										
North Pond-01			X		X	X	X			32 oz. glass jar for TestAmerica
DP-4.10	X	X	X	X	X	X	X			8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica
Pond6-01			X		X	X	X	X	X	32 oz glass jar for TestAmerica 8 oz jar for LEGS
Pond6-02			X		X	X	X	X	X	32 oz glass jar for TestAmerica 8 oz jar for LEGS
DP-4.12	X	X	X	X	X	X	X			8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica
DP-4.13	X	X	X	X	X	X	X			8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica
Pond7-01	X	X	X	X	X	X	X	X	X	8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica 8 oz jar for LEGS
Pond7-02	X	X	X	X	X	X	X	X	X	8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica 8 oz jar for LEGS

**Table 2
Proposed Sediment Sample Matrix**

**Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operable Unit E
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Fort Bragg, California**

Sample Identification and Analysis Method	Porewater PAHs ¹	Sediment PAHs ²	Total Organic Carbon ²	Black Carbon ²	Grain Size ²	pH ²	Oxidation/Reduction Potential, Dissolved Oxygen, pH and Temperature	EMPA ³	Total As ²	Sample Volume
	<i>TestAmerica SOP No. Knox-ID-0018</i>	<i>USEPA 8270C SIM</i>	<i>Lloyd Kahn Method</i>	<i>Modified Lloyd Kahn Method</i>	<i>ASTM D422</i>	<i>USEPA SW 9040B</i>	<i>Field measurement</i>	<i>UC-Boulder LEGS method</i>	<i>USEPA 6010</i>	
Pond 8										
Pond8-01			X		X	X	X			32 oz. glass jar for TestAmerica
Pond8-04			X		X	X	X	X	X	32 oz glass jar for TestAmerica 8 oz jar for LEGS
Pond8-05	X	X	X	X	X	X	X	X	X	8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica 8 oz jar for LEGS
Pond8-06	X	X	X	X	X	X	X			8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica
Pond8-07			X		X	X	X			32 oz. glass jar for TestAmerica
Pond8-08	X	X	X	X	X	X	X			8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica
Pond8-10	X	X	X	X	X	X	X			8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica
Pond8-11			X		X	X	X			32 oz. glass jar for TestAmerica
Pond8-17	X	X	X	X	X	X	X			8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica
Pond8-18			X		X	X	X			32 oz. glass jar for TestAmerica

**Table 2
Proposed Sediment Sample Matrix**

**Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California**

Sample Identification and Analysis Method	Porewater PAHs ¹	Sediment PAHs ²	Total Organic Carbon ²	Black Carbon ²	Grain Size ²	pH ²	Oxidation/Reduction Potential, Dissolved Oxygen, pH and Temperature	EMPA ³	Total As ²	Sample Volume
	<i>TestAmerica SOP No. Knox-ID-0018</i>	<i>USEPA 8270C SIM</i>	<i>Lloyd Kahn Method</i>	<i>Modified Lloyd Kahn Method</i>	<i>ASTM D422</i>	<i>USEPA SW 9040B</i>	<i>Field measurement</i>	<i>UC-Boulder LEGS method</i>	<i>USEPA 6010</i>	
Pond 9										
Pond9-01			X		X	X	X			32 oz. glass jar for TestAmerica
OU-D Riparian										
OU-D-HA-044			X		X	X	X			32 oz. glass jar for TestAmerica
OU-D-HA-045			X		X	X	X			32 oz. glass jar for TestAmerica
OU-D-HA-046			X		X	X	X			32 oz. glass jar for TestAmerica
OU-D-HA-SED-048	X	X	X	X	X	X	X			8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica
OU-D-HA-SED-049	X	X	X	X	X	X	X			8 oz glass jar for TestAmerica 32 oz glass jar for TestAmerica

Notes:

All samples will be taken from 0 to 0.5 ft bss.

Porewater and Sediment PAH analysis will at a minimum quantify those constituents presented in Table 3.

Field personnel will collect two Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples, consisting of collection of triple volume at a sample location.

Field personnel will collect four blind duplicate samples, consisting of collection of double volume at a sample location.

1 - Indicates analyses that should be conducted from 8 oz jar of sediment sent to TestAmerica in Burlington, VT.

2 - Indicates analyses that should be conducted from 32 oz jar of sediment sent to TestAmerica in Burlington, VT.

3- Indicates analyses that should be conducted from 8 oz. jar of sediment sent to the Laboratory for Environmental and Geological Studies (LEGS) at the University of Colorado, Boulder.

Acronyms and Abbreviations

EMPA = Electron microprobe analysis

ft bss = feet bellow sediment surface

LEGS = Laboratory for Environmental and Geological Studies

MS/MSD = Matrix Spike/Matrix Spike Duplicate

PAHs = polycyclic aromatic hydrocarbons

SOP = standard operating procedure

**Table 3
Proposed Porewater Sample Matrix**

**Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California**

Sample Identification and Analysis Method	Total Metals ¹ (25 mL minimum volume)	Total Mercury ¹ (25 mL minimum volume)	Cations ¹ (25 mL minimum volume)	Anions ² (20 mL minimum volume)	Alkalinity ² (30 mL minimum volume)	Sulfide ³ (20 mL minimum volume)	Dissolved Organic Carbon ⁴ (20 mL minimum volume)	Oxidation/Reduction Potential, Dissolved Oxygen, pH and Temperature	Sample Volume
	USEPA 6020	USEPA 7470	USEPA 6010	USEPA 300.0	SM 2320B	USEPA 9030M	SM 5310C	Field measurement	
Ponds 1-4									
Pond1-02	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond2-01	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond2-02	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond3-04	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond3-06	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond3-07	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond3-08	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond3-09	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS

**Table 3
Proposed Porewater Sample Matrix**

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Fort Bragg, California**

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	USEPA 6020	USEPA 7470	USEPA 6010	USEPA 300.0	SM 2320B	USEPA 9030M	SM 5310C	Field measurement	
Pond 5									
Pond5-02	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond5-03	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Ponds 6, 7 and North Pond									
North Pond-01	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond6-01	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond6-02	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
DP-4.13	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond7-01	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond7-02	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS

**Table 3
Proposed Porewater Sample Matrix**

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Sample Identification and Analysis Method	Total Metals ¹ (25 mL minimum volume)	Total Mercury ¹ (25 mL minimum volume)	Cations ¹ (25 mL minimum volume)	Anions ² (20 mL minimum volume)	Alkalinity ² (30 mL minimum volume)	Sulfide ³ (20 mL minimum volume)	Dissolved Organic Carbon ⁴ (20 mL minimum volume)	Oxidation/Reduction Potential, Dissolved Oxygen, pH and Temperature	Sample Volume
	USEPA 6020	USEPA 7470	USEPA 6010	USEPA 300.0	SM 2320B	USEPA 9030M	SM 5310C	Field measurement	
Pond 8									
Pond8-01	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond8-04	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond8-05	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond8-06	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond8-07	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond8-08	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond8-10	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond8-11	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond8-17	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
Pond8-18	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS

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Sample Identification and Analysis Method	Total Metals ¹ (25 mL minimum volume)	Total Mercury ¹ (25 mL minimum volume)	Cations ¹ (25 mL minimum volume)	Anions ² (20 mL minimum volume)	Alkalinity ² (30 mL minimum volume)	Sulfide ³ (20 mL minimum volume)	Dissolved Organic Carbon ⁴ (20 mL minimum volume)	Oxidation/Reduction Potential, Dissolved Oxygen, pH and Temperature	Sample Volume
	USEPA 6020	USEPA 7470	USEPA 6010	USEPA 300.0	SM 2320B	USEPA 9030M	SM 5310C	Field measurement	
Pond 9									
Pond9-01	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
OU-D Riparian									
OU-D-HA-044	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
OU-D-HA-045	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
OU-D-HA-046	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
OU-D-HA-SED-048	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS
OU-D-HA-SED-049	X	X	X	X	X	X	X	X	100 mL pre-preserved (HNO ₃) bottle for ALS 100 mL un-preserved bottle for ALS 100 mL pre-preserved (NaOH + Zn Acetate) bottle for ALS 100 mL pre-preserved (H ₂ SO ₄) for ALS

Notes:

Samples will be taken from the *in-situ* dialysis membrane porewater sampler deployed within the 0 to 0.5 ft bss depth interval.

Field personnel will collect two Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples, consisting of collection of triple volume at a sample location.

Field personnel will collect four blind duplicate samples, consisting of collection of double volume at a sample location.

1 - Indicates analyses that should be conducted from 100 mL, pre-preserved (HNO₃) bottle sent to ALS Environmental in Kelso, Washington.

2 - Indicates analyses that should be conducted from 100 mL, un-preserved bottle sent to ALS Environmental in Kelso, Washington.

3 - Indicates analysis that should be conducted from 100 mL, pre-preserved (NaOH + Zn Acetate) bottle sent to ALS Environmental in Kelso, Washington.

4 - Indicates analysis that should be conducted from 100mL, pre-preserved (H₂SO₄) bottle sent to ALS Environmental in Kelso, Washington.

Acronyms and Abbreviations

ft bss = feet below sediment surface

MS/MSD = Matrix Spike/Matrix Spike Duplicate

**Table 4
Sediment and Porewater Alkylated PAH Analyte List**

**Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California**

Constituents	Constituents Analyzed in Sediment¹	Constituents Analyzed in Porewater²
Naphthalene	X	X
1-Methylnaphthalene	X	X
2-Methylnaphthalene	X	X
Acenaphthylene	X	X
Acenaphthene	X	X
C2 Naphthalenes	X	X
Fluorene	X	X
C3 Naphthalenes	X	X
Anthracene	X	X
Phenanthrene	X	X
C1 Fluorenes	X	X
C4 Naphthalenes	X	X
C1 Phenanthrenes/anthracenes	X	X
C2 Fluorenes	X	X
Pyrene	X	X
Fluoranthene	X	X
C2 Phenanthrenes/anthracenes	X	X
C3 Fluorenes	X	X
C1 Fluoranthenes/pyrenes	X	X
C3 Phenanthrenes/anthracenes	X	X
Benz(a)anthracene	X	X
Chrysene	X	X
C4 Phenanthrenes/anthracenes	X	X
C1-Benzanthracenes/Chrysenes		X
C1 Chrysenes	X	
Benzo(a)pyrene	X	
Perylene	X	
Benzo(e)pyrene	X	
Benzo(b)fluoranthene	X	
Benzo(k)fluoranthene	X	
C2 Chrysenes	X	
Benzo(g,h,i)perylene	X	
C3 Chrysenes	X	
Indeno(1,2,3-cd)pyrene	X	
Dibenz(a,h)anthracene	X	
C4 Chrysenes	X	

Notes:

1- Alkylated polycyclic aromatic hydrocarbons (PAHs) analyte list based on USEPA, 2003. Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures. U.S. Environmental Protection Agency Office of Research and Development. EPA-600-R-02-013.

2- Solid phase microextraction analyte list based on TestAmerica, 2012. Standard Operating Procedure: Solid Phase Micro Extraction and Analysis of Dissolved Parent and Alkyl Substituted Polycyclic Aromatic Hydrocarbons in Sediment Pore Water. TestAmerica Laboratories, Inc. Knoxville, TN.

**Table 5
Human Receptor Exposure Parameters**

**Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California**

Parameter	Symbol	Units	Construction Worker	Utility/Trench Worker	Recreational Visitor in Aquatic Areas		Recreational Visitor in Terrestrial Areas			Commercial/Industrial Worker ^k
			RME	RME	CTE (passive)		CTE (passive)		RME (frequent)	RME
					Child	Adult (passive)	Child	Adult (passive)	Adult (frequent)	
General Factors										
Averaging Time (cancer)	ATc	days	25,550 ^{a,b}	25,550 ^{a,b}	25,550 ^{a,b}	25,550 ^{a,c}	25,550 ^{a,b}	25,550 ^{a,c}	25,550 ^{a,c}	25,550 ^{a,b}
Averaging Time (non-cancer)	ATnc	days	365 ^{a,b}	2,555 ^{a,b}	2,190 ^{a,c}	8,760 ^{a,c}	2,190 ^{a,c}	8,760 ^{a,c}	10,950 ^{a,c}	9,125 ^{a,b}
Body Weight	BW	kg	70 ^{b,c,g,h}	70 ^{b,c,g,h}	15 ^{b,c,f}	70 ^{c,d}	15 ^{b,c,f}	70 ^{c,d}	70 ^{c,d}	70 ^{b,c,g,h}
Exposure Frequency	EF	days/year	250 ^{g,h}	20 ^{PJ}	12 and 50 ^{PJ,5}	12 and 50 ^{PJ,5}	50 ^{PJ,6}	50 ^{PJ,6}	200 ^{PJ,6}	250 ^{b,c,g,h}
Exposure Time	ET	hours/day	8 ^c	8 ^c	1 ^{PJ,6}	1 ^{PJ,5}	1 ^{PJ,6}	1 ^{PJ,5}	1 ^{PJ,5}	8 ^c
Exposure Duration	ED	years	1 ^j	7 ⁱ	6 ^{PJ,5}	24 ^{PJ,5}	6 ^{PJ,5}	24 ^{PJ,5}	30 ^{PJ,5}	25 ^{b,c,g,h}
Groundwater - Ingestion (Oral)										
Groundwater Ingestion Rate	IRgw	L/day	--	--	--	--	--	--	--	2 ^j
Groundwater - Dermal Contact										
Exposed Skin Surface Area	SSAgw	cm ²	2,500 ^{d,1}	2,500 ^{d,1}	--	--	--	--	--	--
Exposure Time	ETgw	hours/day	1 ^{PJ,2}	1 ^{PJ,2}	--	--	--	--	--	--
Surface Water - Dermal Contact										
Exposed Skin Surface Area	SA	cm ²	--	--	750 ^{PJ,3}	3,000 ^{PJ,3}	--	--	--	--
Soil/Sediment - Ingestion (Oral)										
Incidental Soil Ingestion Rate	IRs	mg/day	330 ^f	330 ^f	50 ^{PJ,4}	25 ^{PJ,4}	50 ^{PJ,4}	25 ^{PJ,4}	25 ^{PJ,4}	100 ^j
Soil/Sediment - Dermal Contact										
Exposed Skin Surface Area	SA	cm ²	2,500 ^{d,1}	2,500 ^{d,1}	750 ^{PJ,3}	3,000 ^{PJ,3}	750 ^{PJ,3}	3,000 ^{PJ,3}	3,000 ^{PJ,3}	3,300 ^{d,10}
Skin Adherence Factor	AF	mg/cm ² -day	0.8 ^j	0.8 ^j	0.2 ^f	0.07 ^f	0.2 ^f	0.07 ^f	0.2 ^{PJ,7}	0.02 ^d
Soil - Inhalation of Dust										
Particulate Emission Factor	PEF	m ³ /kg	1.00E+06 ^j	1.00E+06 ^j	--	--	1.32E+09 ^h	1.32E+09 ^h	1.32E+09 ^h	1.32E+09 ^h
Breathing Rate	BR	m ³ /day	20	20	--	--	1.2	1.6	3	13.6
Breathing Rate per hour	BR	m ³ /hour	2.5 ^e	2.5 ^e	--	--	1.2 ^{e,5}	1.6 ^{e,5}	3 ^{PJ,7}	1.7 ^{e,j}

Table 5
Human Receptor Exposure Parameters

Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Notes:

Commercial/industrial worker added from receptors listed for OU-E in the approved Site-Wide RAWP (ARCADIS BBL, 2008). Included in order to assess the potential use of the site as a commercial property in the future.

- a. The averaging period for cancer risk is the expected lifespan of 70 years expressed in days. The averaging period for non-cancer risk is the total exposure period expressed in days.
- b. USEPA (1989) Risk Assessment Guidance for Superfund.
- c. USEPA (1991b) Standard Default Exposure Factors.
- d. USEPA (2004a) Risk Assessment Guidance for Superfund, Vol I, Part E, Supplemental Guidance Dermal Risk Assessment.
- e. USEPA (1997a) Exposure Factors Handbook.
- f. USEPA (2002b) Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.
- g. CalEPA (1992) Supplemental Guidance for Human Health Multimedia Risk Assessment of Hazardous Waste Sites and Permitted Facilities.
- h. USEPA (2004a) Region 9 Preliminary Remediation Goals 2004 Update
- i. CalEPA (2000) Air Toxics Hot Spots Program Risk Assessment Guidelines, Part IV Technical Support Document for Exposure Assessment and Stochastic Analysis.
- j. CalEPA (2005a) Note: Recommended Department of Toxic Substances Control (California) Default Exposure Factors for Use in Risk Assessment at California Military Facilities.
- k. The adult commercial/ industrial receptor was assumed to wear a short-sleeved shirt, long pants, and shoes; therefore, the exposed skin surface is limited to the head, hands, and forearms.
 1. Based on sum of typically exposed body parts of workers: face, forearms, and hands (surface area values are the average between male and female [50th percentile] from USEPA, 2004a). The CTE scenario assumes long-sleeve shirts and therefore subtracts the contribution from forearms.
 2. Based on assumption that workers will exit excavation area for pit dewatering if groundwater collects in any abundance.
 3. Based on the assumption of a jogger/walker scenario, the values for exposed skin surface area for adult and child were calculated using the average of two clothing scenarios recommended by USEPA (2004c): Central tendency mid range (only face and hands exposed [1306 cm²] and (head, hands, forearms, and lower legs [4849 cm²] (Exposure Factors Handbook [EFH] 1997a). Due to significant temperature changes seasonally, the jogger/walker is assumed to be wearing a short-sleeve shirt and shorts during warmer seasons (spring and summer) and a long-sleeve shirt and pants during cooler seasons (fall and winter). The child exposed skin surface area is based on the adult surface area multiplied by 0.25 as recommended by the EFH.
 4. The soil ingestion rate is based on 50% of the recommended USEPA (1997a) values for residential child and adult. Based on studies by Calabrese et al. (1989; as cited in USEPA 1997a) soil accounts for about 50% of the daily ingestion rate, while the other 50% is attributed to indoor house dust; therefore, for the recreational receptors, the ingestion rate was divided by half to account for only the outdoor exposure at the site. Furthermore, this value is considered conservative given that the ingestion dose equation assumes that all time spent outdoors is spent at the site, as the soil ingestion exposure equation does not account for the 1 hour/day event time (Fraction Ingested from site =1 for ingestion pathway).
5. Passive and Frequent recreators are expected to visit the applicable aquatic portions of the site for recreational purposes 1 hour per day at a frequency of 1 day per month for 30 years. A frequency of 1 hour per for 50 days per year for 30 years will also be evaluated. Passive recreators (Child/Adults) are assumed to engage in moderate activities such as walking, while frequent recreators (Adults) are assumed to engaged in more strenuous activities such as jogging.
6. Passive recreators are expected to visit the applicable terrestrial portions of the site for recreational purposes 1 hour per day at a frequency of 1 day per week for 30 years, and engage in moderate activities such as walking. Frequent recreators (Adult joggers/walkers) are expected to visit the terrestrial portions of the site 1 hour per day and up to 4 days per week for 30 years.
7. Department of Toxic Substances Control (California) recommended value per Comments dated September 14, 2007 (DTSC 2007).
9. A conservative estimate based on the USEPA (1997a) residential value of 50 mg/day. The worker is onsite 8 hours per day compared to the 24 hours for the resident and the worker is onsite 5 days per week compared to the resident, which is 7 days per week, therefore using the residential ingestion rate is considered a conservative estimate for the worker receptor.
10. The adult commercial/industrial receptor was assumed to wear a short-sleeved shirt, long pants, and shoes; therefore, the exposed skin surface is limited to the head, hands, and forearms (average of male and female for 50 percentile from Table 6-2 and 6-3 of USEPA, 1997a). For the CTE scenario, long-sleeve shirts are assumed, therefore subtracting the contribution from forearms.
11. The CTE scenario assumes light activities for commercial/industrial worker and moderate activities for construction and trench/utility workers as presented in Table 5-23 (USEPA, 1997a).

Acronyms and Abbreviations

Cal/EPA = California Environmental Protection Agency

cm² = square centimeter(s)

CTE = central tendency exposure

EFH = Exposure Factors Handbook

kg = kilogram(s)

L = liter(s)

m³ = cubic meter(s)

mg = milligram(s)

PJ = professional judgment (see text in the Site-wide RAWP (ARCADIS BBL 2008a))

RAWP = Risk Assessment Work Plan

RME = reasonable maximum exposure

USEPA = U.S. Environmental Protection Agency

Table 5
Human Receptor Exposure Parameters

Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

References:

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**Table 6
Ecological Receptor Exposure Parameters**

**Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California**

Parameter	Units	Killdeer		American Kestrel		Ornate Shrew	
Ingestion Rate: Food	kg/day	0.015	Calculated with body weight of 75.6 grams using the equation (Equation 39) for the food requirement for dry matter intake for charadriiformes (shore birds) (Nagy 2001) .	0.020	Calculated with body weight of 116 grams using the equation (Equation 63) for the food requirement for intake of dry matter for carnivorous birds (Nagy 2001).	0.0010	Ingestion rates for food calculated using equation from Nagy (2001) for insectivorous mammals.
Ingestion Rate: Soil	kg/day	0.0025	17.5% of food ingestion rate, median value for sandpiper species used as surrogate (dry weight) (Beyer et al. 1994).	0.0012	Based on red-tailed hawks (dry weight) (Research Triangle Institute 1994).	0.000020	2.4% of food ingestion rate was assumed (Beyer et al 1994).
Fraction of Diet: Vegetation	Unitless	0	Annual diet about 98% animal matter, mostly insects, some small crustaceans and snails, and <2% plant material. Cited in Birds of North America (Jackson and Jackson 2000).	0	From Meyer and Balgooyen (1987) American kestrels in open areas and woodlands of California, in USEPA (1993).	0	Feeds on insects and other invertebrates. (Hoffman 1999) as cited in California Wildlife Habitat Relationships Database (California Department of Fish and Game 2002).
Fraction of Diet: Invertebrate	Unitless	1		0.33		1	
Fraction of Diet: Prey/Fish	Unitless	0		0.67		0	
Foraging Range	Acres	1745	May travel up to 1.5 kilometer to forage (Cogswell 1970) as cited in California Wildlife Habitat Relationships Database (California Department of Fish and Game 2002). 1.5 kilometers used as the radius of the homerange.	194	From Rudolph (1982) low data point estimate for foraging distance for breeding American kestrels located in Yolo County, California. Found in Cal/ECOTOX Database http://www.oehha.ca.gov/cal_ecotox/report/falcsef.pdf (CalEPA 2003).	0.25	Based on home range for short-tailed shrew (Platt 1976) in USEPA (1993).
Site Use Factor ^a	Unitless	0.006	Based on terrestrial habitat	0.057	Based on terrestrial habitat	1	Based on terrestrial habitat
Body Weight	kg	0.0756	Cited in Birds of North America (Jackson and Jackson 2000) average mass of two males found in Georgia/North Carolina.	0.116	Average of California males and females from Bloom (1973) in USEPA (1993).	0.0048	From the CRC Handbook of Mammalian Masses (Silva and Downing 1995).

**Table 6
Ecological Receptor Exposure Parameters**

**Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California**

Parameter	Units	Mule Deer		Red Fox		Mallard	
Ingestion Rate: Food	kg/day	1.57	Food ingestion rate of Mule deer reported in Nagy (2001), Table 1.	0.14	From Sergeant (1978) adult ingestion rate after whelp, in USEPA (1993).	0.078	Calculated with body weight of 1,121 grams using the equation for the food requirement for dry matter intake for all birds (Nagy 2001).
Ingestion Rate: Soil	kg/day	0.031	< 2% (2% used in calculation) of food ingestion rate (dry weight) (Beyer et al. 1994).	0.005	2.8% of food ingestion rate was assumed (Beyer et al 1994).	0.0026	3.3% of food ingestion rate for mallards (dry weight) (Beyer et al. 1994).
Fraction of Diet: Vegetation	Unitless	1	Mule Deer browse and graze on new growth shrubs, forbs, and grasses (Wallmo 1978) as cited in California Wildlife Habitat Relationships Database (California Department of Fish and Game 2002).	0	The proportion of dietary items is based on information from Hockman and Chapman (1983) presented in USEPA (1993). The unknown portion of the red fox's diet is apportioned to the other dietary components. Will model as eating 100% small mammals.	0.70	The diet of mallards consists of grains, seeds, leaves, aquatic plants, grasses, mollusks, and insects (Bent 1923; Martin et al. 1961). Fall and winter diet consists of almost 100% plants by dry weight and the spring and summer diet consists of 28 to 63% plants and 37 to 72% invertebrates by dry weight (USEPA 1993).
Fraction of Diet: Invertebrate	Unitless	0		0		0.30	
Fraction of Diet: Prey/Fish	Unitless	0		1		0	
Foraging Range	Acres	247	Based on the low estimate of typical home ranges for does and fawns in Lake County, California (Taber and Dasmann 1958; as cited in California Wildlife Habitat Relationships Database (California Department of Fish and Game 2002).	1004	Based on average of male and female home ranges from Ables (1969) in USEPA (1993).	274	Based on average home range of laying females in North Dakota prairie pot holes, Dwyer et al. (1979) in USEPA (1993).
Site Use Factor ^a	Unitless	0.045	Based on terrestrial habitat	0.011	Based on terrestrial habitat	0.04 0.04	Based on terrestrial habitat Based on aquatic habitat
Body Weight	kg	39	Mass of Mule deer reported in Nagy (2001) Table 1.	4.54	Average of mean body weights of adult males and females, spring and fall weights (3.94 to 5.25 kg) from Storm et al (1976) in USEPA (1993).	1.12	Average of male and female body weights from Tule Lake National Wildlife Refuge in northeast California (Karpu 1979)

**Table 6
Ecological Receptor Exposure Parameters**

**Baseline Human Health and Ecological Risk Assessment Work Plan Addendum - Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California**

Parameter	Units	Virginia Rail		Raccoon		California Quail	
Ingestion Rate: Food	kg/day	0.01	Calculated with body weight of 84.1 grams using the equation for the food requirement for intake of dry matter for omnivorous birds (Nagy 2001).	0.15	Ingestion rates for food calculated using equation from Nagy (2001) for omnivorous mammals.	0.0094	Calculated with body weight of 189 grams using the equation (Equation 45) for the food requirement for dry matter intake for galliformes (quails) (Nagy 2001).
Ingestion Rate: Soil	kg/day	0.0004	3.3% of food ingestion rate. Mallards sediment ingestion rate used as a surrogate (dry weight) (Beyer et al. 1994).	0.014	9.4% of food ingestion rate was assumed (Beyer et al. 1994).	0.00087	9.3% of food ingestion rate, wild turkey used as surrogate (dry weight) (Beyer et al. 1994).
Fraction of Diet: Vegetation	Unitless	0.15	Diet varies seasonally, but consists primarily of insects (62%). Virginia rails also feed on various marsh plants, seeds, snails, crayfish, and small fishes. Dietary proportions are reported for Virginia rails in Southern Iowa. Cited in Birds of North America (Conway 1995). Invertebrate tissue estimates were used as a surrogate for the fish portion of the diet.	0.58	Raccoons are omnivorous and opportunistic feeders. Raccoons feed primarily on fleshy fruits, nuts, acorns, and corn (Kaufmann 1982; as cited in USEPA 1993); but also eat grains, insects, frogs, crayfish, eggs, and virtually any animal and vegetable matter (Palmer and Fowler 1975; as cited in USEPA 1993). The proportion of different foods in their diet depends on location and season, although plants are usually a more important component of the diet. The proportion of dietary items is based on information from USEPA (1993).	1	Annual diet about 95% plant matter, mostly legumes and weeds, followed by grasses and fruit, <5% animal material. Cited in Birds of North America (Calkins et al. 1999). Will model as eating 100% plant material.
Fraction of Diet: Invertebrate	Unitless	0.85		0.42		0	
Fraction of Diet: Prey/Fish	Unitless	0		0		0	
Foraging Range	Acres	4.05	Based mean home range of Virginia rails in Arizona during the breeding season. Cited in Birds of North America (Conway 1995).	96	Based on data in USEPA (1993).	1.2	Based on the low estimate of foraging ranges for incubating mating pairs in California as described in the California Wildlife Habitat Relationships Database (California Department of Fish and Game 2002).
Site Use Factor ^a	Unitless	1	Based on aquatic habitat	0.11	Based on aquatic habitat	1	Based on terrestrial habitat
Body Weight	kg	0.084	Average of males and female body weights from Southern Arizona. Cited in Birds of North America (Conway 1995).	5.78	Average of mean body weights of adult males and females (3.67 to 7.6 kg) presented in USEPA (1993).	0.189	Cited in Birds of North America (Jackson and Jackson 2000) average mass of males and females found in Contra Costa and San Mateo Counties, California.

Table 6
Ecological Receptor Exposure Parameters

Baseline Human Health and Ecological Risk Assessment Work Plan - Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Notes:

a. A habitat-specific site use factor (SUF) was calculated (i.e., SUF = terrestrial or aquatic acreage/foraging range). Terrestrial acreage = 11.1; aquatic acreage = 10. The BHHERA will also present a sensitivity analysis of potential hot spot exposure for aquatic upper trophic level receptors by evaluating each pond AOC separately using area use factors based on the respective pond AOC acrages.

Acronyms and Abbreviations

kg = Kilogram

SUF = site use factor

USEPA = United States Environmental Protection Agency

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Table 7
Toxicity Reference Values

Baseline Human Health and Ecological Risk Assessment Work Plan Addendum- Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Constituent	Toxicity Reference Values for Wildlife (mg/kg-day) ^a							
	Mammals			Birds				
	Low TRV	High TRV	Method	Low TRV	High TRV	Method		
Metals								
Antimony	0.059		0.59	#1	NA		NA	
Arsenic	1.04		1.66	#1	2.24		3.6	#2
	0.32	d	4.7	d	5.5	d	22	d
Barium	51.8		121	#3	20.8	b	41.7	b
Beryllium	0.53		0.63	#2	NA		NA	
Cadmium	0.77		7.7	#1	1.47		5.88	#3
	0.06	d	2.64	d	0.08	d	10.40	d
Chromium	2.4		9.62	#3	2.66		2.78	#3
Cobalt	7.33		19.3	#3	7.61		11.5	#3
	1.2	d	20.0	d	NA		NA	
Copper	5.6		9.34	#2	4.05		12.1	#1
	2.67	d	632.00	d	2.3	d	53.3	d
Lead	4.7		8.90	#2	1.63		3.3	#1
	1	d	241	d	0.014	d	8.75	d
Mercury	0.25	d	4	d	0.039	d	0.18	d
Molybdenum	0.26	b	2.6	b	3.5	b	35.3	b
Nickel	1.7		3.4	#1	6.71		21.0	#3
	0.133	d	31.6	d	1.38	d	56.3	d
Selenium	0.05	d	1.21	d	0.23	d	0.93	d
Silver	6.02		60.2	#4	2.02		20.2	#4
Thallium	0.48	d	1.43	d	0.35	c	3.5	c
Vanadium	4.16		8.31	#1	0.34		0.7	#1
Zinc	75.4		87.1	#3	66.1		87.1	#3
	9.6	d	411	d	17.2	d	172	d
Polycyclic Aromatic Hydrocarbons (PAHs)								
Dibenzofuran	50	d,g	150	d,g	22.8	h	228	h
Total HMW PAH	1.31	d,k	32.8	d,k	10.0	i	100	i
Total LMW PAH	50	d,g	150	d,g	22.8	h	228	h
Semi Volatile Organic Compounds (SVOCs)								
Bis(2-ethylhexyl)phthalate	18.3	b	183	b	1.1	b	11.1	b
Butyl Benzyl Phthalate	18.3	m,	183	m, b	1.1	m,	11.1	m, b
Di-n-Butylphthalate	550	b	1833	b	0.11	b	1.1	b
Polychlorinated Biphenyls (PCBs)								
Total PCB Congeners	0.36	d	1.28	d	0.09	d	1.27	d
Volatile Organic Compounds (VOCs)								
1,3,5-Trimethylbenzene	NA		NA		NA		NA	
1,1 - Dichloroethene	30	b	300	b, f	NA		NA	
1,1-Dichloroethane	475	e	4750	e, f	17.2	b,q	34.4	b,q
Benzene	26.4	b	264	b	NA		NA	
Carbon Disulfide	11	o	25	o	NA		NA	
Chlorobenzene	19	n	38	n	NA		NA	
Chloroform	15	b	41	b	NA		NA	
Ethylbenzene	29.1	p	291	p, l	NA		NA	
Isopropylbenzene	NA		NA		NA		NA	
n-Butylbenzene	NA		NA		NA		NA	
n-Propylbenzene	NA		NA		NA		NA	
p-Isopropyl Toluene	NA		NA		NA		NA	
sec-Butylbenzene	NA		NA		NA		NA	
Tert-Butylbenzene	NA		NA		NA		NA	
Tetrachloroethene	1.4	b	7	b	NA		NA	
Toluene	26	b	260	b	NA		NA	
Xylenes, total	2.1	b	2.6	b	NA		NA	
Vinyl Chloride	0.17	b	1.7	b	NA		NA	
Dioxin/Furans								
Dioxin TEQ (avian)	NA		NA		0.0000140	j	0.0001400	j
Dioxin TEQ (mammal)	0.0000010	j	0.0000100	j	NA		NA	

Table 7
Toxicity Reference Values

Baseline Human Health and Ecological Risk Assessment Work Plan Addendum- Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

Notes:

- a. From USEPA (2008) *Ecological Soil Screening Level Guidance* (unless otherwise noted).
- # The numeric identification in the method column represents the rule applied for how the LOAEL-based TRVs were derived from the EcoSSL document. The number and associated rules are as follows:
 - #1. If the recommended NOAEL-based TRV was bounded, the LOAEL from the same study and endpoint was selected.
 - #2. If the recommended NOAEL-based TRV was unbounded, the lowest reproduction, growth and survival LOAEL greater than the NOAEL-based TRV was selected.
 - #3. If the recommended NOAEL-based TRV was a geometric mean of the reproduction and growth NOAELs, the lower value from the following two methods was selected as the LOAEL TRV: (1) the geometric mean of bounded reproduction and growth LOAELs was calculated, and if no bounded NOAELs or LOAELs were contained in the dataset, the lowest reproduction or growth LOAEL greater than the NOAEL-based TRV was conservatively selected as the LOAEL-based TRV. (2) the lowest bounded LOAEL for survival endpoints.
 - #4. If the recommended NOAEL-based TRV was derived from a LOAEL to which uncertainty factors were applied, the LOAEL without those uncertainty factors was used as the LOAEL-based TRV.
- b. From Sample et al. (1996).
- c. From USEPA (1999); reported NOAEL values are used as the low TRV and the "Dose" (i.e., before uncertainty factors were applied) reported is used as the high TRV. Reported LOAEL values are used as the high TRV and an UF of 10 applied to calculate low TRV.
- d. DTSC (2009) BTAG TRVs for birds and mammals.
- e. NOAEL TRV developed from Klaunig et al (1986).
- f. An UF of 0.1 was applied to extrapolate a high TRV from the NOAEL-based TRV.
- g. Naphthalene used as a surrogate for TRV derivation.
- h. Avian TRVs for low molecular weight PAHs were developed using available literature; Patton and Dieter (1980).
- i. Mammalian TRVs for high molecular weight PAHs were developed using available literature; Trust et al (1994).
- j. Based on 2,3,7,8-tetrachlorodibenzodioxin (TCDD). Consistent with the DTSC-approved Site-Wide RAWP (ARCADIS BBL, 2008c), the TCDD TRVs presented for birds and mammals were obtained from Sample et al., 1996.
- k. Benzo(a)pyrene used as a surrogate for TRV derivation.
- l. An UF of 10 was applied to extrapolate a low TRV from the LOAEL-based TRV.
- m. Bis(2-ethylhexyl)phthalate used as a surrogate for TRV derivation
- n. Derived from Monsanto, 1967; Knapp, 1971
- o. Derived from Hardin et al. 1981 (low); Jones-Price et al. 1984 (high)
- p. Derived from Wolf et al., 1956
- q. 1,2-dichloroethane used as a surrogate.

Acronyms and Abbreviations

BTAG = Biological Technical Advisory Group
DDT = dichloro-diphenyl-trichloroethane
DTSC = California Department of Toxic Substances Control
g/g/day = gram per gram per day
HMW = high molecular weight
LMW = low molecular weight
LC₅₀ = median lethal concentration
LOAEL = lowest observed adverse effect level
mg/kg = milligrams per kilogram
mg/kg-day = milligrams per kilogram per day
mg/kg bw-day = milligrams per kilogram body weight per day
NA = not available
NOAEL = no observed adverse effect level
OU-E = Operable Unit E
TEQ = toxicity equivalence
TRV = toxicity reference value
UF = uncertainty factor
USEPA = United States Environmental Protection Agency

Table 7
Toxicity Reference Values

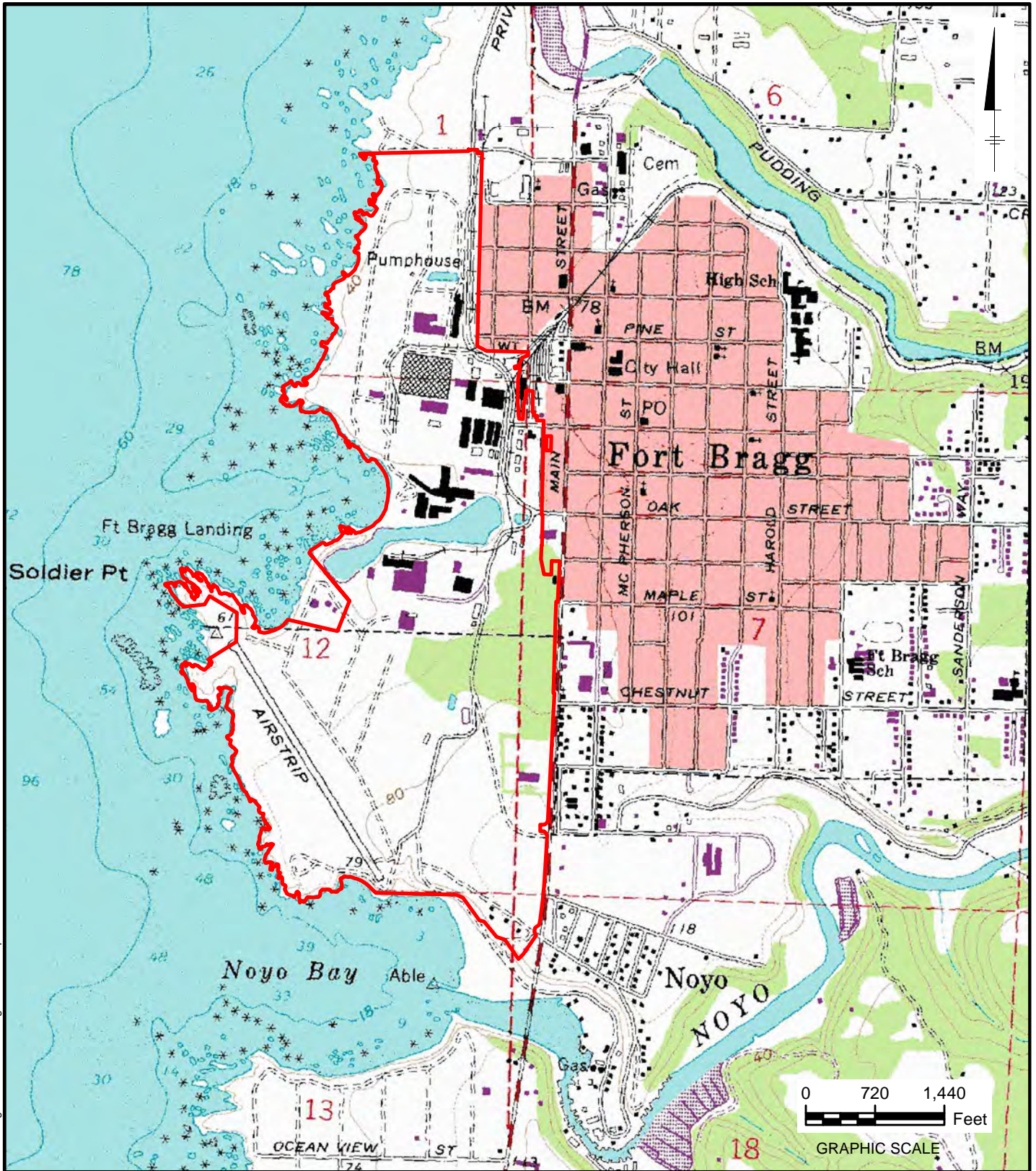
Baseline Human Health and Ecological Risk Assessment Work Plan Addendum- Operable Unit E
Former Georgia-Pacific Wood Products Facility
Fort Bragg, California

References:

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Figures



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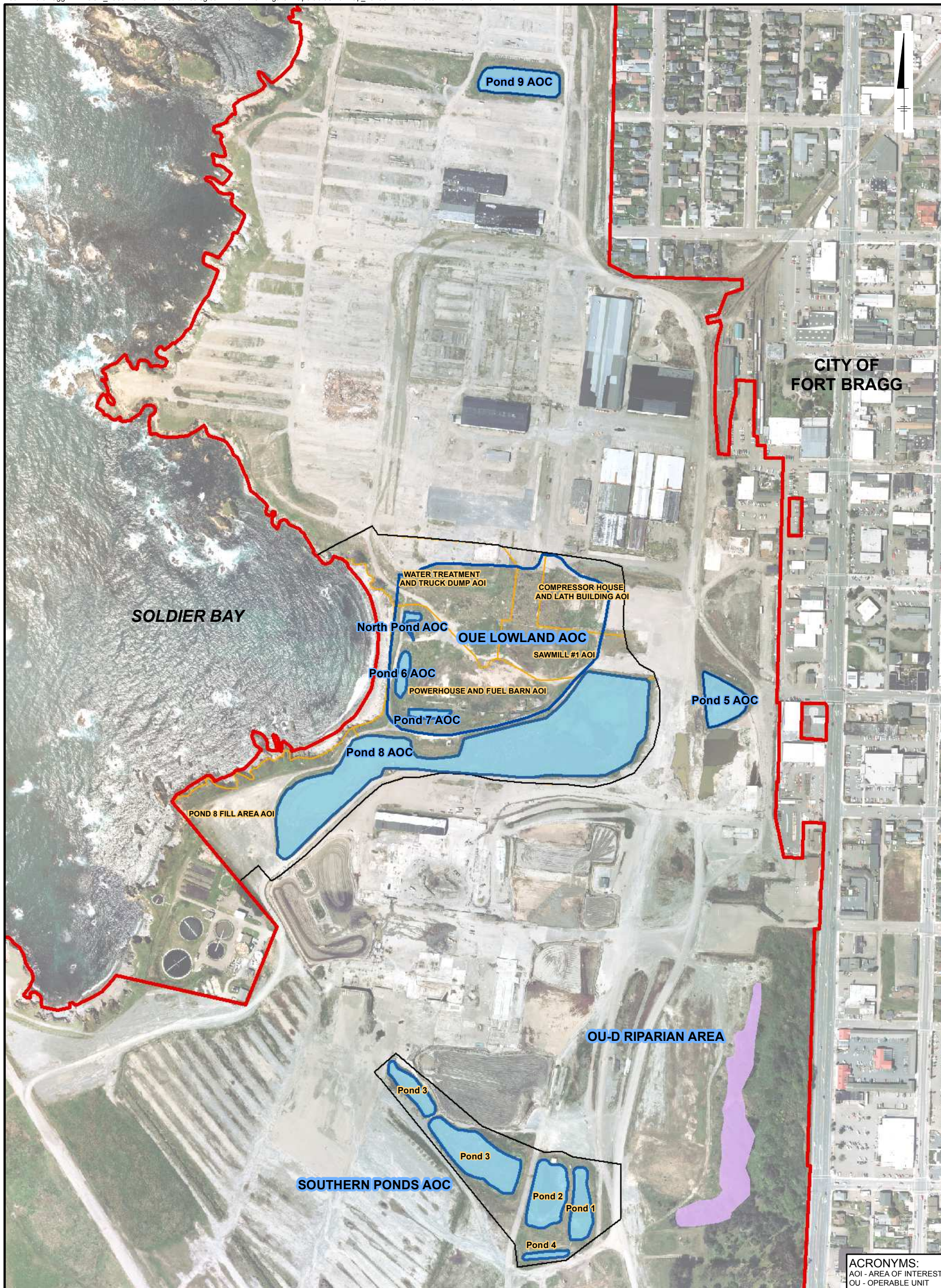
 SITE BOUNDARY

FORMER GEORGIA-PACIFIC WOOD PRODUCTS FACILITY
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 BASELINE HUMAN HEALTH AND ECOLOGICAL RISK
 ASSESSMENT WORK PLAN ADDENDUM - OPERABLE UNIT E

SITE LOCATION MAP



FIGURE 1



ACRONYMS:
 AOI - AREA OF INTEREST
 OU - OPERABLE UNIT

LEGEND:

- SITE BOUNDARY
- AOI BOUNDARY
- OU-E BOUNDARY
- PONDS
- AREA OF CONCERN BOUNDARY
- OU-D RIPARIAN AREA

AREAS OF CONCERN:

- OUE LOWLAND
- SOUTHERN PONDS
- POND 5
- PONDS 6 & 7 AND NORTH POND
- POND 8
- POND 9



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OPERABLE UNIT-E MAP



FIGURE 2

CITY: Highlands Ranch DIV/GROUP: IM GIS DB:BG:Griffith
 Project: B0066142.0006 task 1
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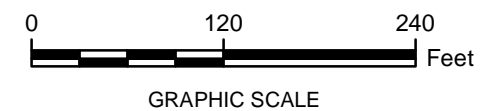


LEGEND:

HISTORICAL SAMPLE LOCATIONS	
◆	SEDIMENT
⊙	SEDIMENT/SURFACE WATER
PROPOSED SAMPLE LOCATIONS	
●	POREWATER ANALYSES
●	PAH AND BLACK CARBON ANALYSES
●	ARSENIC SPECIATION
▭	SITE BOUNDARY
▭	OU-E BOUNDARY
▭	POND

NOTE:
 TOTAL ORGANIC CARBON, GRAIN SIZE, pH,
 DISSOLVED OXYGEN, TEMPERATURE AND
 OXIDATION/REDUCTION POTENTIAL WILL BE
 COLLECTED FROM ALL SAMPLING LOCATIONS.

ACRONYM:
 OU-E OPERABLE UNIT E



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**OU-E PONDS 6-8 AND NORTH POND
 PROPOSED SAMPLING LOCATIONS**

ARCADIS | **FIGURE 3**



LEGEND:

PROPOSED SAMPLE LOCATIONS

- POREWATER ANALYSES
- PAH AND BLACK CARBON ANALYSES

HISTORICAL SAMPLE LOCATIONS

- ◆ SEDIMENT
- SEDIMENT/SURFACE WATER

- ARSENIC SPECIATION

- SITE BOUNDARY

- OU-E BOUNDARY

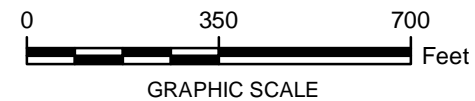
- POND

NOTES:

TOTAL ORGANIC CARBON, GRAIN SIZE, pH, DISSOLVED OXYGEN, TEMPERATURE AND OXIDATION/REDUCTION POTENTIAL WILL BE COLLECTED FROM ALL SAMPLING LOCATIONS.

THE LOCATION OF POND 9-01 IS APPROXIMATE

ACRONYM:
 OU-E OPERABLE UNIT E



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**OU-E PONDS 5 AND 9
 PROPOSED SAMPLING LOCATIONS**



FIGURE 4

CITY: Highlands Ranch DIV/GROUP: IM GIS DB: BGriffith
 Project B0066142.0006 task 1
 Path: I:\FortBragg\MXD\OU-E_BaselineHumanHealthEcologicalRA\WorkPlan\Figure 5 SouthernPondsSamplingLocs_20130214.mxd Date: 2/15/2013 Time: 2:11:27 PM



LEGEND:

PROPOSED SAMPLE LOCATIONS

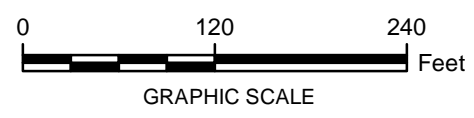
- POREWATER ANALYSES
- PAH AND BLACK CARBON ANALYSES
- ARSENIC SPECIATION
- OU-E BOUNDARY
- POND

HISTORICAL SAMPLE LOCATIONS

- ◆ SEDIMENT
- SEDIMENT/SURFACE WATER

NOTE:
 TOTAL ORGANIC CARBON, GRAIN SIZE, pH,
 DISSOLVED OXYGEN, TEMPERATURE AND
 OXIDATION/REDUCTION POTENTIAL WILL BE
 COLLECTED FROM ALL SAMPLING LOCATIONS.

ACRONYM:
 OU-E OPERABLE UNIT E

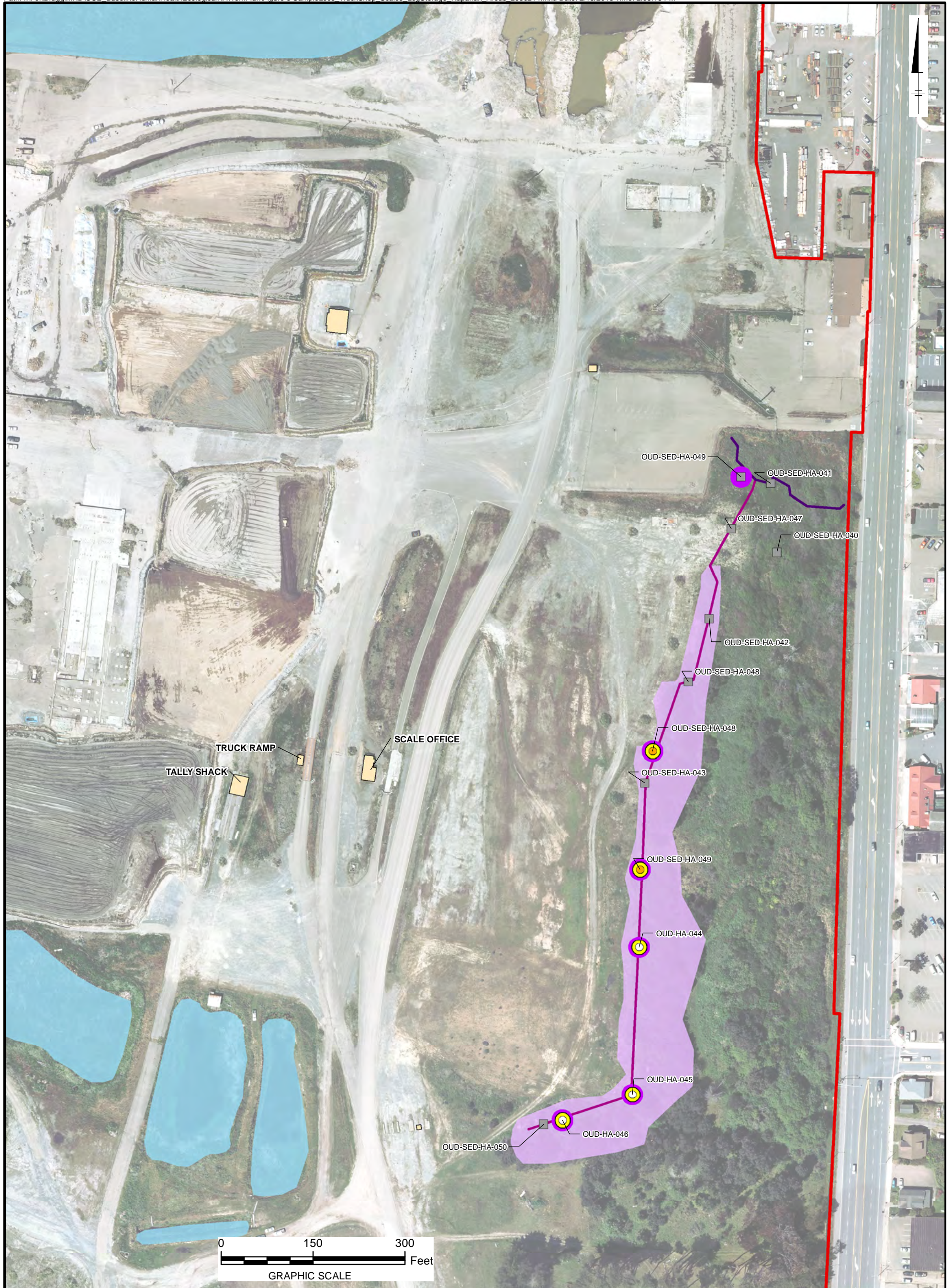


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**OU-E PONDS 1-4 PROPOSED
 SAMPLING LOCATIONS**



FIGURE 5



LEGEND:
HISTORICAL SAMPLE LOCATIONS

■ SURFACE/SUBSURFACE SEDIMENT

PROPOSED SAMPLE LOCATIONS

● POREWATER ANALYSES
 ● PAH AND BLACK CARBON ANALYSES

● ARSENIC SPECIATION
 ■ SITE BOUNDARY
 ■ POND
 ■ STRUCTURE
 ■ RIPARIAN AREA
 ■ RIPARIAN WETLAND
 ■ SEASONAL WETLAND DITCH

NOTE:
 TOTAL ORGANIC CARBON, GRAIN SIZE, pH,
 DISSOLVED OXYGEN, TEMPERATURE AND
 OXIDATION/REDUCTION POTENTIAL WILL BE
 COLLECTED FROM ALL SAMPLING LOCATIONS.

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**OUD RIPARIAN AREA
 PROPOSED SAMPLING LOCATIONS**



FIGURE 6

Potential Exposure Media

Exposure Media

OU-E Terrestrial

Potential Exposure Media	Exposure Media	EXPOSURE PATHWAY(S)	Potential Human Receptors						Potential Ecological Receptors			
			Maintenance/Utility/Trench Worker	Construction Worker	Commercial/Industrial Worker	Passive Adult/Child Recreator	Frequent Adult Recreator	Plants	Soil inverts	Birds	Mammals	
Surface and Subsurface Soil ↓ Leaching from Soil to Groundwater	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 pathway
- ✓* Potentially complete but likely insignificant pathway

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 limited to 2 feet below the groundwater table.

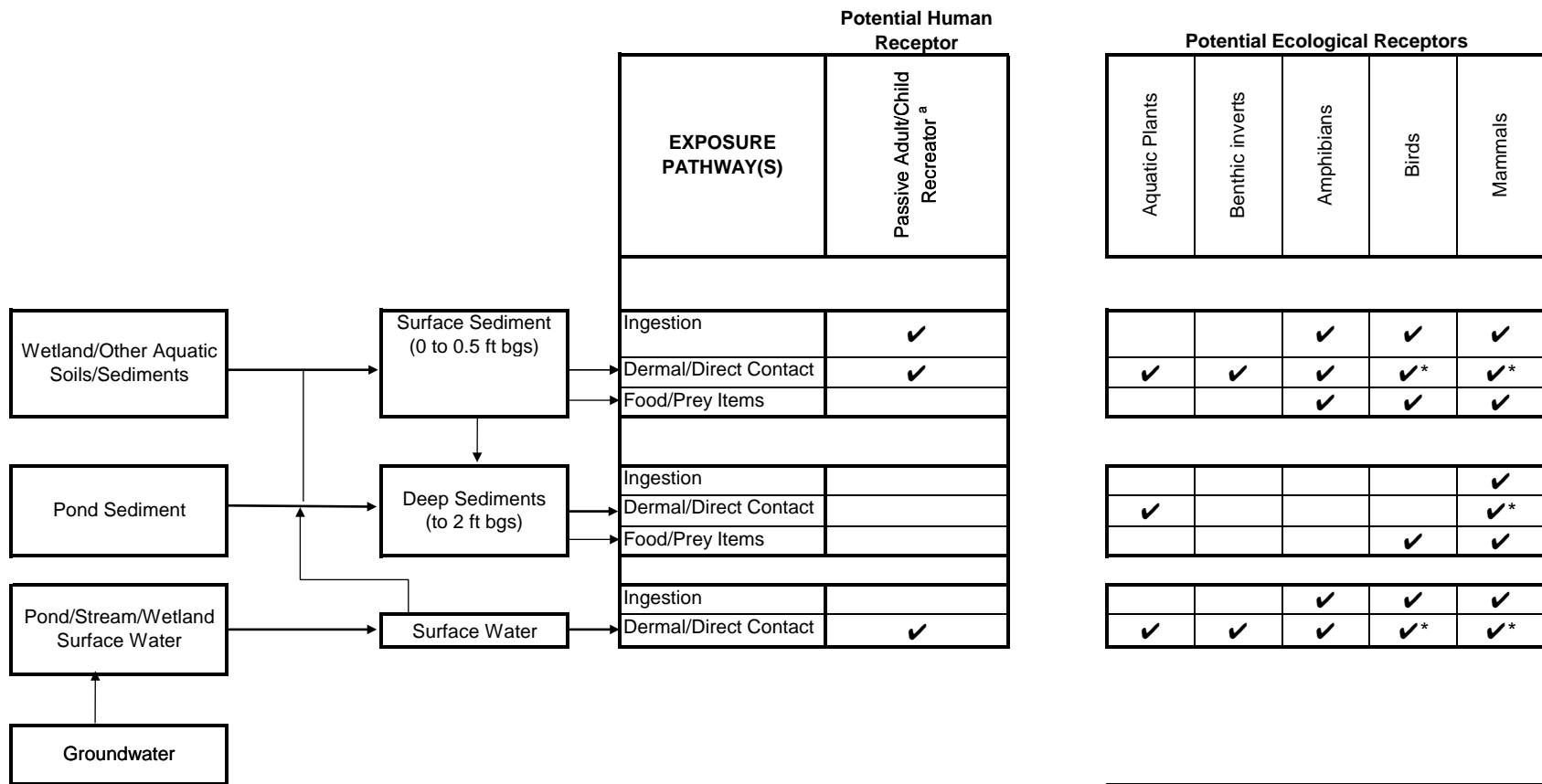
Additional receptor from those approved in the June 2008 *Site-Wide Risk Assessment Work Plan* (submitted by ARCADIS on behalf of Georgia-Pacific), included in order to assess the potential use of the site as a commercial property.

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TERRESTRIAL AREA CONCEPTUAL SITE MODEL	
	FIGURE 7

Potential Exposure Media

Exposure Media

OU-E Wetland/Aquatic



- Notes:
- ✓ Potentially complete exposure pathway
 - ✓* Potentially complete but likely insignificant 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.

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WETLAND/AQUATIC AREA CONCEPTUAL SITE MODEL	
	Figure 8

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Appendix A

**Standard Operating
Procedure: Porewater
sampling using an *in-situ*
dialysis membrane sampling
apparatus**

Rev. #: 0

Rev Date: February 8, 2013

Approval Signatures



Prepared by: _____

Date: 13 February 2013



Prepared by: _____

Date: 13 February 2013



Reviewed by: _____

Date: 13 February 2013

(Technical Expert)

I. Scope and Application

Porewater sampling will occur to assess concentrations of dissolved-phase constituents in sediment of Operable Unit E (OU-E) ponds at the Former Georgia Pacific Wood Products Facility in Fort Bragg, CA. Field personnel will install diffusion controlled *in-situ* dialysis membrane porewater samplers (DMPS) to collect data. De-oxygenated, de-ionized (DI) water will be placed inside of the dialysis membrane and the sampler will be installed in the 0-0.5 ft. below sediment surface (bss) depth interval of the surficial sediment. The sampler will be left in the sediment for a minimum of 12 days to allow for the constituent concentrations in the sampler to reach equilibrium with surrounding porewater and no more than 14 days to reduce potential for degradation of the dialysis membrane. DMPS allow for the analysis of *in-situ* conditions and reduce the influence of sampling artifacts (e.g., oxidation and temperature) on data collection.

II. Personnel Qualifications

ARCADIS field personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervision training, and site-specific health and safety training. In addition, personnel overseeing, directing, or supervising sediment collection will be versed in the applicable Standard Operating Procedures (SOPs) to successfully complete the sampling activities and be experienced with general sampling methods used in aquatic environments (e.g., sediment, surface water, an/or porewater).

III. Equipment List

The following equipment will be required during *in-situ* pore water sampling activities:

- Personal protective equipment (PPE) and safety equipment as required by the site health and safety plan (HASP) and Job Safety Analysis (JSA).
- *In-situ* DMPS:
 - 5 inch (in.) x 1 in. (Length (L) x inner diameter (ID)) slotted PVC pipe;
 - Acetate cellulose tubular dialysis membrane (ACDM; 8,000 dalton nominal molecular weight cutoff) cut into 15 in. strips with stainless steel or ceramic scissors;
 - 2 in. outer diameter closed pipe nipples;
 - Rubber stop corks;
 - 8 in. x 2.0 in. (L X ID) protective slotted PVC sheath;

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- Manufactured DMPS sampling apparatus (top and bottom push-rod/anchor made out of slotted PVC and plexiglass “snowshoe”);
- Stainless steel or ceramic scissors;
- 50 milliliter (mL) pipette and pipette bulb;
- 5 gallon buckets with lid and air lock;
- Laboratory grade helium or nitrogen tank (including regulator and necessary hoses);
- Air stone;
- GPS equipment with sub-meter accuracy and sample locations entered;
- Chest waders;
- Boat (aluminum Jon boat and lightweight inflatable);
- Field probe with capabilities to measure oxidation-reduction potential (ORP), dissolved oxygen (DO), temperature and pH;
- Slide hammer;
- Hand auger with 1.5 in. screw head;
- Laminated site location map (with sample locations marked);
- Laboratory supplied sample containers;
- Indelible ink pen and ball point pen;
- Transport cooler(s) with ice;
- Laboratory supplied DI water;
- Field log book;
- Digital camera;
- Sample labels;
- Canopy and stakes/weights;
- Decontamination supplies (see Field Sampling Equipment Decontamination Procedures SOP, No. 1213199) and;
- Sample packaging and shipping supplies (see Field Sample Packing, Handling and Shipping SOP, No 1223199)

IV. Cautions

Helium/nitrogen tanks must be delivered to the site by an appropriate agent complying with Materials of Trade, Department of Transportation, and/or International Air Transport Association regulations, as necessary. Helium/nitrogen tanks must be stored and transported on-site in compliance with appropriate Materials of Trade and health and safety regulations.

If inclement weather occurs, then sampling must be conducted under cover to prevent potential contamination of porewater samples by rainwater.

To prevent oxidation of the porewater samples, the deployment and retrieval procedures must take place as quickly as possible, and agitation of the sampler should be minimized during deployment and retrieval.

If DMPS are to be used to sample for VOCs, then packing tape must be avoided on the sample containers to prevent contamination. If DMPS are to be used to sample for metals, then stainless steel or ceramic tools should be used to prevent contamination.

If a slide hammer must be used to insert the DMPS into the sediment, use caution as to not damage the sampling device. Use the hammer as gently as possible and position as best as possible in areas clear of debris and rocks.

To the extent possible, store and/or stage empty and full sample containers and coolers out of direct sunlight and under ice.

Be careful not to spill laboratory-prepared containers that may contain preservatives. Reduction of the preservative in the container may impact the integrity of the sample and analytical results and is a health and safety concern.

Shipping determinations must be made for samples to be collected prior to mobilization for the field event, and appropriate measure must be taken to ship the samples in accordance with Department of Transportation, and/or International Air Transport Association regulations.

V. Health and Safety Considerations

Always review and follow site specific SOPs and consult the site-specific HASP and JSAs.

Wear appropriate PPE and have safety equipment specified by the site HASP and JSAs. Use caution when transporting boats and working over water.

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Follow appropriate health and safety standards and regulations for storing and transporting compressed gas cylinders.

VI. Procedure

Sampling devices will be custom manufactured and are modified based on methods described by Vrobleski et al., (2002).

Probe assembly:

1. Don PPE as specified by the HASP and JSA.
2. Decontaminate DMPS pieces and 5 gallon buckets to be used to hold DMPS during deoxygenation.
3. Place laboratory supplied DI water into the previously decontaminated 5 gallon buckets.
4. Assemble helium tank with regulator, hoses and air stone at end of discharge hose. Slowly turn on gas release valve to gauge appropriate pressure (i.e., seals and hoses maintain integrity) and evaluate potential leaks. If pressure is too high or if leaks are present, then turn off regulator and adjust tubing. Repeat this step as necessary to achieve appropriate pressure and stop leaks.
5. Bubble helium gas into a sufficient number of the DI filled buckets to hold all DMPS for the event until the dissolved oxygen (DO) concentration falls below 0.5 mg/L as measured by a calibrated field probe (see Measuring Basic Water Quality Parameters In-Situ SOP, No 1343199). Keep remaining DI filled buckets for the following step.
6. Label two buckets filled with DI water "1st rinse" and "2nd rinse".
7. Cut strips of ACDM to lengths of approximately 15 in. using scissors and dip the strip twice into the bucket labeled "1st rinse" and twice into the bucket labeled "2nd rinse" to remove any residual packing solution.
8. Insert the 5 in. x 1 in. (L x ID) slotted PVC pipe into ACDM and tie an overhand knot at one end of the ACDM.
9. Submerge the ACDM into the de-oxygenated, DI water, making sure that the bag is completely filled. Tie an overhand knot on the loose end of the sampler

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to seal the bag. Turn the ACDM upside down to make sure that it is completely sealed.

10. Place the ACDM inside of its protective sheath (to create the DMPS); making sure that the sampler remains submerged in the de-oxygenated DI water. Screw on PVC nipples, with rubber stop cork previously inserted, to both ends of the DMPS. Keep the DMPS in the de-oxygenated, DI water with continuous helium bubbling until deployment.

Sampler deployment:

1. Don PPE, as required by the HASP and JSAs. If necessary, deploy the boat into the water body where sampler will be installed. Follow the boat deployment, trailering, and transport JSA when handling the boat.
2. Use GPS survey equipment to locate the proposed sample location. If sample location must be relocated from the pre-determined locations, then field staff must contact the Task Manager and/or Project Manager to discuss potential relocation of the location. Survey and document field modifications to sample locations, when necessary, and note reasons for the modification in the field notebook.
3. Identify the proposed sample location in the field notebook, along with other appropriate information collected during sediment sampling activities (i.e., texture, color, presence of debris, presence of oily sheen, and presence of organic matter, and odor; see Sediment Sampling with Dewatering SOP, No 1383199a).
4. Record the sampling location and station position with the GPS.
5. Submerge calibrated field probe (with push-rod if necessary) into the surficial sediment and record ORP, DO, temperature, and pH. Be careful not to force the probe, which may result in breakage of the sampling equipment. Record measurements in field notebook.
6. If sediment collection activities are proposed at the sample location, sediment samples will be collected directly adjacent to the area of porewater collection prior to porewater sampler deployment to prevent disturbance of the surface sediment that may occur during the porewater sampler deployment/retrieval process.

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7. On shore (or onboard the boat if used), remove the DMPS from the de-oxygenated, DI water and attach to the spike and push-rod pieces of the sampling apparatus by screwing the pieces together.
8. Lower the sampling apparatus through the water column until it reaches the sediment surface (as judged by field staff using a sediment probe with a flat head).
9. Once the sediment surface is encountered, mark the distance on the sampling apparatus with permanent marker above the water surface that is equal to the distance between the bottom of the sampling apparatus and 1 in. above the top of the DMPS.
10. Insert the sampling apparatus perpendicular into the sediment until the mark made in step 8 is level with the water surface of the water.
11. If the sediment is too compact to direct push the sampling apparatus, then gently use a slide hammer to install the sampler to its appropriate depth. If the sampling apparatus will not install gently using a slide hammer, then dig a pilot hole using a 1.5 in. diameter screw head hand auger before perform the sampling apparatus final installation.
12. After the sampler has been inserted to its appropriate depth, place the weighted plexiglass "snow-shoe" on top of the DMPS by sliding in onto the push-rod and making sure that it encounters the sediment surface by probing with a piece of PVC.
13. Repeat steps 6 through 11 to deploy DMPS with sufficient volume to meet analytical needs.

Sampler retrieval:

1. Don PPE, as required by the HASP and JSAs. Identify the sample location in the field notebook.
2. Use GPS survey equipment, as well as visual inspection of the push-rod, to accurately locate the original sample location.
3. Record changes of the sampler location from the initial placement, as necessary, with the GPS.

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4. Submerge calibrated field probe (with push-rod if necessary) into the surficial sediment and record DO, pH, oxidation-reduction potential (ORP) and temperature. Record measurements in field notebook.
5. Remove the sampling apparatus by slowly pulling the push-rod. Disassemble the DMPS from the sampling apparatus and pour as much residual sediment inside the spike and/or push-core back into the pond, directly above the location from which it was removed.
6. Bring the sampling apparatus to a stable platform (e.g., boat deck or shore), taking care not to agitate the device to prevent oxidation of the porewater samples. Sampling location should be under a canopy or cover, if necessary, dependent on weather (see Section IV of this SOP).
7. Un-screw the segments of the DMPS and remove the ACDM as soon as possible following retrieval; sampling of the DMPS should begin within 20 minutes of retrieval to prevent oxidation of the sample and precipitation of metals from solution. Dip the ACDM into a bucket of DI water to remove gross adsorption of sediment particles. Cut the knot off of the ACDM and pipette sample into laboratory supplied sampling containers, making sure not to place any residual sediment into the sample container.
8. Place push-core and spike into appropriate location for decontamination procedure.

VII. Waste Management

Materials generated during the sediment sampling and decontamination activities along with disposable equipment will be transported for off-site disposal in accordance with project requirements and applicable State regulations.

VIII. Data Recording and Management

Daily sampling activities will be recorded in the field notebook. Photographs of sampling apparatuses and field activities will be taken as appropriate, and photographs taken will be recorded (e.g., subject matter, photograph location, and photograph facing) in the field notebook. Copies of the field notebook will be forwarded to the Project Manager or designee, as requested. Upon completion of the field activities, field notebooks will be maintained in the project files.

IX. Quality Assurance

Field-derived quality assurance blanks will be collected as specified in the Work Plan, depending on the project quality objectives. There will be one method blank carried out on a DMPS apparatus for the de-oxygenated, DI water procedure. There will be another method blank carried out each day of the retrieval process on the scissors used to cut the ACDM.

X. References

Vrobleski DA, Petkewich MD, and Campbell TR. 2002. Field Tests of Diffusion Samplers for Inorganic Constituents in Wells and at a Groundwater-Discharge Zone. United States Geological Survey. Water Resources Investigations Report 02-4031.