FINAL

Phase IV Sampling Results
Technical Memorandum

Richmond Field Station Site

Berkeley Global Campus at Richmond Bay

University of California, Berkeley

Prepared for

Office of Environment, Health and Safety

University of California, Berkeley

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May 16, 2016

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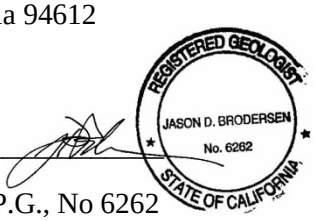

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May 16, 2016

Lynn Nakashima
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Subject: **Final Phase IV Sampling Results Technical Memorandum**
Richmond Field Station Site
Berkeley Global Campus at Richmond Bay
Site Investigation and Remediation Order I/SE-RAO 07/07-004

Dear Ms. Nakashima:

Please find enclosed the Final Phase IV Sampling Results Technical Memorandum for the Richmond Field Station Site (two copies on paper and disc). This document addresses DTSC comments provided on August 7, 2015 and April 22, 2016.

If you have any questions or need further information regarding this submittal, please call me at (ghaet@berkeley.edu, 510-642-4848) or Karl Hans (khans@berkeley.edu, 510-643-9574).

Sincerely,

Greg Haet, P.E.
EH&S Associate Director
Environmental Protection

Enclosure

cc: Bill Marsh, Edgcomb Law Group

CONTENTS

ACRONYMS AND ABBREVIATIONS v

1.0 INTRODUCTION 1

1.1 PHYSICAL SETTING 2
1.2 INVESTIGATION PURPOSE 3

2.0 FIELD ACTIVITIES 6

2.1 UTILITY CLEARANCE 6
2.2 HAND AUGERING AND SOIL SAMPLING IN THE UPLAND MEADOWS 6
2.3 EXPLORATORY EXCAVATION IN THE BULB 8
2.3.1 Pre-Excavation Activities 8
2.3.2 Exploratory Excavation Activities 9
2.4 PASSIVE SOIL GAS SAMPLING IN THE CARBON TETRACHLORIDE AREA 11
2.5 PIEZOMETER INSTALLATION IN THE BAPB AREA 12
2.5.1 Piezometer Installation 12
2.5.2 Piezometer Development 13
2.5.3 Groundwater Sampling 13
2.5.4 Permits and Permit Compliance 13
2.6 WASTE CHARACTERIZATION AND DISPOSAL 14

3.0 DATA QUALITY ASSESSMENT 16

3.1 DATA QUALITY OBJECTIVES 16
3.2 LABORATORY DATA REVIEW 17
3.3 DATA QUALITY REVIEW FINDINGS 17
3.4 ANALYSIS OF TRIPLICATE SOIL SAMPLE DATA 20
3.5 DEVIATIONS 21

4.0 DATA EVALUATION 22

4.1 UPLAND MEADOWS SOIL SAMPLING RESULTS 22
4.1.1 Metals 22
4.1.2 PAHs 26
4.1.3 PCBs 26
4.1.4 VOCs 27
4.1.5 Pesticides 27
4.2 EXPLORATORY EXCAVATION RESULTS 27
4.3 CARBON TETRACHLORIDE PASSIVE SOIL GAS SAMPLING RESULTS 28
4.4 BAPB AREA GROUNDWATER SAMPLING RESULTS 29
4.4.1 Metals 29

4.4.2 VOCs 30

5.0 SUMMARY 31

5.1 UPLAND MEADOWS SOIL SAMPLING RESULTS SUMMARY 31

5.2 EXPLORATORY EXCAVATION RESULTS SUMMARY 31

5.3 CARBON TETRACHLORIDE PASSIVE SOIL GAS SAMPLING RESULTS SUMMARY 31

5.4 BAPB AREA GROUNDWATER SAMPLING RESULTS SUMMARY 31

6.0 REFERENCES 32

CONTENTS (Continued)

Figures

1 Site Location Map

2 Berkeley Global Campus at Richmond Bay Land Uses

3 Phase IV Sampling Areas

4 Site Map

5 Shallow Groundwater Elevation Contours, October 1, 2014

6 Upland Meadows Sampling Locations

7 Carbon Tetrachloride Passive Soil Gas Sampling Locations and Detected Results

8 BTEX and TPH Passive Soil Gas Sampling Locations and Detected Results

9 Nickel Groundwater Concentrations in and Upgradient of the BAPB Area

10 Zinc Groundwater Concentrations in and Upgradient of the BAPB Area

11 Mercury Groundwater Concentrations in and Upgradient of the BAPB Area

12 Shallow Groundwater Elevation Contours, April 1, 2015

13 EPA Meadow North Supplementary PCB Sampling Results

Tables

1 Sampling Registry

2 BAPB Area Piezometer Completion Summary

3 BAPB Area Groundwater Sampling Parameters Summary

4 Upland Meadows Triplicate Soil Sampling Data and Percent Relative Standard Deviation

5 Statistical Summary of Chemicals Detected in Upland Meadows Soil

6 Upland Meadows Soil Detected Metals Compared to Human Health Screening Criteria

7 Upland Meadows Soil Detected Metals Compared to Ecological Screening Criteria

8 Upland Meadows Soil Detected PAH Compared to Human Health and Ecological Screening Criteria

9 Upland Meadows Soil Detected PCB Compared to Human Health and Ecological Screening Criteria

10 Upland Meadows Soil Detected Pesticide Compared to Human Health and Ecological Screening Criteria

11 Carbon Tetrachloride Area Detected VOCs in Soil Gas

12 BAPB Area Groundwater Detected Metals Compared to Aquatic Screening Criteria

13 BAPB Area Groundwater Detected VOCs Compared to Aquatic Screening Criteria

CONTENTS (Continued)

Appendices

A Complete Analytical Results for Upland Meadows Soil Samples

B Complete Analytical Results for Passive Soil Gas Samples from the Carbon Tetrachloride Source Area

C Complete Analytical Results for BAPB Area Groundwater Samples

D Photograph Log of WSM01 Piezometer Installation

E Record of Biological Monitoring and Location of Observed Ridgway's Rail

F Distribution of Metals in the Upland Meadows, With Samples for Specific Sample Locations Emphasized

G 95 UCL Calculation Methods

H Response to Comments

Attachments *(provided on CD only)*

1 Curtis & Tompkins, Ltd. Laboratory Report for Upland Meadows Soil Samples

2 Amplified Geochemical Imaging, LLC Laboratory Report for Passive Soil Gas Samplers

3 Curtis & Tompkins, Ltd. Laboratory Report for BAPB Area Groundwater Samples

4 Chain-of-Custody Forms

5 Bulb Composite Soil Sampling Results for Determination of Air Chemicals of Concern

6 DTSC 2014 Magnetic Anomaly Survey of the Bulb

7 Bulb1 and Bulb2 Groundwater Sampling Results

8 Final Completion Report, Exploratory Excavation for Magnetic Anomaly Source in Bulb

9 BAPB Area Piezometer Boring Logs, Well Development Logs, and Monitoring Well Data Sheets

ACRONYMS AND ABBREVIATIONS

4,4'-DDD	4,4'-dichlorodiphenyldichloroethane
4,4'-DDE	4,4'-dichlorodiphenyldichloroethylene
4,4'-DDT	4,4'-dichlorodiphenyltrichloroethane
95 UCL	One-sided 95 percent upper confidence limit of the mean
µg	Micrograms
µg/L	Micrograms per liter
µrem/hr	Microrems per hour
AGI	Amplified Geochemical Imaging
AST	Aboveground storage tank
BAPB	Biologically active permeable barrier
Bay Trail	East Bay Regional Parks District Bay Trail
BCDC	San Francisco Bay Conservation and Development Commission
BGC	Berkeley Global Campus at Richmond Bay
bgs	Below ground surface
BO	Biological Opinion
BTEX	Benzene, toluene, ethylbenze, and xylenes
CCR	Current Conditions Report
CDFW	California Department of Fish and Wildlife
CDPB-RHB	California Department of Public Health – Radiologic Health Branch
CSM	Conceptual site model
CWA	Clean Water Act
DPT	Direct push technology
DQO	Data quality objective
DTSC	Department of Toxic Substances Control
Eco-SSL	Ecological soil screening level
EH&S	Department of Environment, Health & Safety
EMF	Electromagnetic Field
EPA	U.S. Environmental Protection Agency
ERD	Enhanced reductive dechlorination
ETA	Eastern Transition Area
FSP	Field Sampling Plan
FSW	Field Sampling Workplan
GSU	Geological Services Unit
H_2S	Hydrogen sulfide
HASP	Health and Safety Plan
HSA	Hollow stem auger

IDW	Investigation-derived waste
ITRC	Interstate Technology Regulatory Council
LaBr Probe	LaBr IPROL-1 probe (S/N 04074637)
LCS	Laboratory control sample
LRDP	Long Range Development Plan
MDL	Maximum Detection Limit
MFA	Mercury fulminate area
mg/kg	Milligrams per kilogram
MS/MSD	Matrix spike/matrix spike duplicate
MTBE	Methyl tert-butyl ether
NOS	Natural Open Space
NGVD	National Geodetic Vertical Datum
NWP	Nationwide Permit
ORNL	Oak Ridge National Laboratory
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PID	Photoionization detector
PVC	Polyvinyl chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
QL	Quantitation Limit
RAW	Remedial Action Workplan
RBC	Richmond Bay Campus
RES	Research, Education, and Support
RFS	Richmond Field Station
RFS Order	Site Investigation and Remediation Order No. IS/E-RAO 06/07-004 for the Richmond Field Station
RSD	Relative Standard Deviation
RWQCB	San Francisco Bay Regional Water Quality Control Board
SCR	Site Characterization Report
SIM	Selective ion monitoring
SVOC	Semivolatile organic compound
TPH	Total petroleum hydrocarbons
TSCA	Toxic Substances Control Act
UC	University of California
USACE	U.S. Army Corps of Engineers

USFWS	U.S. Fish and Wildlife Service
VOC	Volatile organic compound
WTA	Western Transition Area

1.0 INTRODUCTION

On May 15, 2014, The Regents of the University of California (UC) approved the Berkeley Global Campus at Richmond Bay (BGC) as a new major research facility on properties it owns in Richmond, California. The BGC is composed of portions of the Former Richmond Field Station (RFS) and the Regatta Property located west of the Former RFS (Figure 1). The BGC will provide for development of additional research facilities for both UC Berkeley and the Ernest Orlando Lawrence Berkeley National Laboratory for academic teaching, applied research, and collaborations with private industry focused on energy, environment, and health. The Long Range Development Plan (LRDP) for the property (UC 2014), initially named the Richmond Bay Campus (RBC), identifies the developable portion of the new campus as Research, Education, and Support (RES), and the remainder as Natural Open Space (NOS). RES and NOS land uses are shown on Figure 2.

UC Berkeley has been conducting investigation and cleanup actions at the Former RFS under oversight of the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC), in compliance with the Site Investigation and Remediation Order, Docket No. IS/E-RAO 06/07-004 for the Richmond Field Station, dated September 15, 2006 (RFS Order). The RFS Order provides for investigation and cleanup of 96 acres of upland and 13 acres of tidal marsh and transition habitat within the Former RFS Site.

The property defined under the RFS Order is referred to as the "Former RFS Site," "Former RFS," or "Site." The Former RFS Site does not encompass the entire RFS; two outboard parcels located off shore are not included in the RFS Order. Also, the Regatta Property, which is included in the BGC, is not included in the RFS Order. Figure 1 shows the Former RFS Site in relation to the BGC, Regatta Property, and outboard parcels.

This Phase IV Technical Memorandum was prepared on behalf of UC in accordance with the RFS Order; it presents the results of four field investigation activities as proposed in the Phase IV Field Sampling Plan (FSP), dated October 6, 2014 (Tetra Tech 2014c), and Phase IV FSP Addendum 1 dated October 28, 2014 (Tetra Tech 2014d). The field investigation activities consist of soil sampling in the Upland Meadows, an exploratory excavation to investigate the magnetic anomaly in the Bulb, passive soil gas sampling to investigate a source of carbon tetrachloride in the Carbon Tetrachloride Area, and the placement of additional groundwater piezometers near the biologically active permeable barrier (BAPB); Figure 3 shows locations of these activities.

All Phase IV field activities were conducted in accordance with the Field Sampling Workplan (FSW) Phase I Groundwater Sampling Plan, dated June 2, 2010 (Tetra Tech 2010), the Phase IV FSP (Tetra Tech 2014c), and the Phase IV FSP Addendum 1 (Tetra Tech 2014d). The objective of the Phase IV FSP and Addendum 1 was to address data gaps identified in the Current Conditions Report (CCR) (Tetra Tech 2008) and to identify immediate or potential risks to public health and the environment.

This memorandum presents a summary of field activities, data quality assessment, data evaluation, and figures and tables summarizing results of detected concentrations. Appendix A, Appendix B, and Appendix C provide complete analytical results, and Appendix D presents a photograph log of field activities. Appendix E includes a record of biological monitoring, Appendices F and G present Upland Meadows metals distribution plots and statistical methodologies. Appendix H presents the response to comments on the draft version of this report. Laboratory reports and field forms for all sampling investigations including in this technical memorandum are presented in Attachments 1 through 4, and

documentation of the Bulb exploratory excavation activities are included in Attachments 5 through 8. Attachment 9 includes the BAPB Area piezometer field documentation.

This final technical memorandum addresses comments received from DTSC dated August 7, 2015 on the Draft Phase IV Sampling Results Technical Memorandum, dated June 5, 2015, as documented in Appendix H, Response to Comments.

1.1 PHYSICAL SETTING

The Site is at 1301 South 46th Street, Richmond, California, along the southeastern shoreline of the City of Richmond on the San Francisco Bay and northwest of Point Isabel (see Figure 1). It consists of upland areas developed for academic teaching and research activities, an upland remnant coastal terrace prairie, a tidal salt marsh, and a transition zone between the upland areas and marsh. Between the late 1800s and 1948, several companies, including the California Cap Company, manufactured explosives at the Site. In 1950, The UC Regents purchased the property from the California Cap Company. UC Berkeley initially used the RFS for research for the College of Engineering; later, it was also used by other campus departments.

The Phase IV FSP included proposed plans for investigations at three areas at the Former RFS Site (see Figure 4) (Upland Area, Transition Area, and Western Stege Marsh).

1) The Upland Area consists of 96 acres of land bounded by Meade Street to the north, South 46th Street to the east, the Transition Area to the south, and Meeker Slough and Regatta Boulevard to the west (see Figure 2; Figure 4).
2) The Transition Area, made up of the Western Transition Area (WTA) and Eastern Transition Area (ETA), occupies approximately 5.5 acres and is bounded to the north by the Upland Area at the location of a buried, former seawall believed to have been the edge of the historical mudflats; and to the south by Western Stege Marsh at the 5-foot elevation upper extent of the marsh (National Geodetic Vertical Datum [NGVD] 29). The Transition Area is believed to consist entirely of artificial fill placed on historical mudflats.
3) The Western Stege Marsh, including the original marsh and remediated portion, occupies approximately 7.5 acres, and is bounded by the Transition Area to the north, the RFS connector trail to the East Bay Regional Park District Bay Trail (Bay Trail) and East Stege Marsh to the east, the Bay Trail to the south, and Meeker Slough and Marina Bay housing development to the west.

The Site includes a number of distinct and varied habitats resulting from both natural and human activities. The Upland Area hosts numerous research facilities with associated out-buildings surrounded by landscaped trees and plants. The eastern and central portions of the Upland Area are largely developed with few natural ecological conditions present. The western portion of the Upland Area contains one of the largest and best-preserved areas of native coastal grasslands within the Big Meadow – grasslands once prevalent throughout the San Francisco Bay Area (see Figure 4).

The Western Transition Area and a portion of the Eastern Transition Area consist of mainly mixed coastal ruderal scrub. Most of the coastal scrub habitat is disturbed and intermixed with non-native invasive grasses and forbs along with some native shrubs (coyote bush, poison oak, and toyon). Portions of the Eastern Transition Area consist of restored coastal terrace prairie and ecotone transition to the tidal salt

marsh edge that was re-vegetated beginning in 2004 after remediation with locally-native prairie and marsh edge plants.

The southern portion of the Site is the least developed and consists of a low salt marsh, middle salt marsh, high salt marsh, and tidal wetlands. Plants include both native and non-native species, and attract a variety of special-status species birds such as the Federally-endangered Ridgway's Rail (*Rallus obsoletus*).

1.2 INVESTIGATION PURPOSE

Section 5.3.1 of the RFS Order requires preparation of a FSW to conduct site investigations to address data gaps identified in the CCR that warrant additional characterization or evaluation. The FSW specified five phases of field investigations to address these data gaps (Tetra Tech 2010). The FSW is a site-wide document covering all investigation phases and a site-wide project background, objectives, conceptual site model (CSM), schedule for investigating the Site, a Quality Assurance Project Plan (QAPP), and a facility-wide Health and Safety Plan (HASP). An updated CSM, including results from the FSP Phase I through III investigations, is included in the Site Characterization Report (SCR) (Tetra Tech 2013a).

The FSW also serves as the FSP for Phase I, a site-wide groundwater investigation, conducted from 2010 to 2012. The Phase I FSW field effort consisted of installation and sampling of 51 piezometers throughout the Site (see Figure 5), as well as semi-annual groundwater monitoring of the piezometers in 2011 and 2012. Beginning in 2012, annual site-wide groundwater monitoring has been conducted in the spring, with a subset of wells sampled (40 of 50) beginning April 2013. Data acquired from the installed and developed piezometers — including chemical results from groundwater samples, geological information, and depth to water measurements — were referenced to develop a hydrogeologic model of the Site, and to improve understanding of overall site-wide groundwater quality.

Phase II investigated soil conditions at current and former transformer locations, the Corporation Yard along the eastern property boundary, and aboveground storage tanks (AST).

Phase III consisted of further delineation of mercury in the mercury fulminate area (MFA); characterization of soils in the former Dry House explosion area, Building 128, and Building 201 soil mounds; grab groundwater sampling for further delineation of carbon tetrachloride near piezometer CTP; and additional delineation of polychlorinated biphenyl (PCB) contamination in the transformer and Corporation Yard areas.

The scope of the Phase IV FSP is consistent with the phased approach to the site-wide investigation presented in the FSW, and addresses identified data gaps as well as areas identified by DTSC as needing further investigation. The scope of the investigations included in this report are:

- Soil investigations in the Upland Meadows consisting of the Big Meadow, U.S. Environmental Protection Agency (EPA) Meadow North, and the West Meadow
- Exploratory excavation to investigate the magnetic anomaly in the Bulb within the WTA
- Additional sampling to identify a possible source of the carbon tetrachloride detected in shallow groundwater (approximately 12 feet below ground surface [bgs]) in the carbon tetrachloride area
- Further characterization of groundwater in the vicinity of the BAPB

The Phase IV sampling areas are shown on Figure 3, and described below.

- Big Meadow, EPA Meadow North, and West Meadow. These Upland Meadows are designated within the NOS with a combined acreage of 15.6 acres, and are composed of disturbed, undeveloped coastal terrace prairie and non-native grasslands habitat. As proposed in the LRDP (UC 2014), these areas will remain undeveloped and protected as open space habitat. Soil sample results will be used to evaluate the soil and evaluate potential risks to human and ecological receptors.
- Carbon Tetrachloride Area. The carbon tetrachloride area is within the Upland Area portion of the Site in the Big Meadow. Carbon tetrachloride was detected at concentrations exceeding drinking water standards in all shallow groundwater samples collected from piezometer CTP, screened between 7 and 17 feet bgs, as well as during subsequent, ongoing yearly monitoring (Tetra Tech 2013b). An evaluation of groundwater sampling data and the site conceptual model did not identify immediate or potential threats to human health or the environment; however, continued seasonal groundwater monitoring confirmed elevated concentrations of carbon tetrachloride exceeded drinking water standards in groundwater samples collected from piezometer CTP (Tetra Tech 2012; 2013a, 2013b). Grab groundwater samples collected during the FSP Phase III field investigation indicated presence of carbon tetrachloride near piezometer CTP, but because of slow recharge during sampling, the results were used only to determine the presence or absence of carbon tetrachloride. A soil gas investigation in the vicinity of piezometer CTP was proposed under the Phase IV field activities as the next effort to help determine if contaminated soil exists in the area as source of the carbon tetrachloride detected in shallow groundwater and to determine if areas of elevated groundwater contamination are present within the study area.
- The Magnetic Anomaly. The magnetic anomaly identified in the Bulb is within the WTA and within fill placed on the mudflat adjacent to the Western Stege Marsh. In November 2005, a former RFS employee alleged that drums containing rocks had been buried in the Bulb in the late 1960s (Tetra Tech 2008). The former employee claimed he had been told to avoid handling the rocks because they were allegedly radioactive. In response to this information, DTSC conducted a magnetometer survey of the Bulb in 2006, and discovered a magnetic anomaly approximately 170 feet south-southwest of the concrete pad (identified as “impoundment” on Figure 6) indicating possible presence of buried ferrous metal material at the location of the anomaly. The purpose of the exploratory excavation proposed under the Phase IV field activities was to determine the source of the detected magnetic anomaly. No removal of drums was anticipated during the exploratory investigation. If drums were discovered, samples of the drum contents, if accessible, were to be collected and characterized through submittal of samples to an analytical laboratory and through use of real-time radiation detection instrumentation.

- BAPB Area Groundwater. Between December 2010 and May 2012, Terraphase Engineering, Inc., a consultant for Zeneca, a previous owner of the adjacent Campus Bay property, completed additional investigations of the BAPB, which extends from the adjacent Campus Bay Site onto the Former RFS Site in the ETA and the remediated portion of Western Stege Marsh. As part of these investigations, Zeneca completed a cone penetrometer test investigation to collect lithology and grab groundwater data from the area upgradient and downgradient of the BAPB; this data was used to identify appropriate locations to install monitoring wells. Zeneca then installed monitoring wells upgradient, downgradient, and within the BAPB to further monitor the post remedial condition of groundwater in that area and to assess the functionality of the BAPB. The monitoring wells have been and will continue to be assessed for concentration trends for metals and VOCs detected in groundwater in that area. The monitoring well installation and initial sampling results are documented in the Draft Groundwater Investigation Within and In the Vicinity of the BAPB at the UC RFS (Terraphase 2012), in which Terraphase concluded that the BAPB was performing as designed. DTSC agreed with the conclusion, but in its letter responding to the report, DTSC required additional investigations to further assess effectiveness of the BAPB, including the objective to "collect grab groundwater samples from locations upgradient, downgradient, and to the west of the BAPB to assess the distribution of dissolved metals and [volatile organic compounds] VOCs in groundwater" (DTSC 2013).

  In response to DTSC's comment, Terraphase completed additional groundwater well installations in October 2013 on behalf of Zeneca downgradient of the BAPB (piezometers MW-43, MW-45, and MW-46) and conducted sampling (Terraphase 2014). A review of the results from these investigations indicated groundwater concentrations of metals and VOCs in certain wells exceeding aquatic screening criteria (Terraphase 2012, 2014).

  In response to DTSC's comment, UC proposed to install four additional piezometers were proposed upgradient and crossgradient of the BAPB under the Phase IV field activities. Groundwater data acquired from these new piezometers as part of the Phase IV field investigation will be assessed in conjunction with the data collected by Terraphase along the BAPB to evaluate if additional groundwater sampling activities are warranted for this area. The additional data is intended to identify concentrations of metals and VOCs upgradient and cross-gradient of the BAPB. The new piezometers are not intended to monitor the functionality of the BAPB.

The Phase IV FSP includes background and history of the Phase IV investigation areas, purpose of sampling, data quality objectives (DQO), proposed sample locations, site-specific sampling strategies, and chemicals of potential concern for the Phase IV data gaps investigation.

2.0 FIELD ACTIVITIES

The sampling strategy for Phase IV consisted of: (1) collection of discrete soil samples in the Big Meadow, EPA Meadow North, and West Meadow; (2) performing an exploratory excavation in the Bulb at the magnetic anomaly; (3) collection of passive soil gas samples in the Big Meadow; and (4) performing additional groundwater characterization near the BAPB in the ETA and remediated portion of Western Stege Marsh. Sampling locations, depths, and the analytical suite are presented in Table 1.

2.1 UTILITY CLEARANCE

Prior to subsurface disturbance in the Upland Meadows, the presence of utilities in the vicinity of the 42 proposed sampling locations was assessed to determine where utility clearance was required. Utility clearance was warranted at six sampling locations due to the close proximity of utilities to sampling locations. The six locations (UM12, UM23, UM27, UM29, UM30, and UM32), situated on the eastern edge of the Big Meadow and adjacent to Lark Drive (Figure 6), were scoped to be hand-augered to 2 feet bgs in areas adjacent to roads where subsurface disturbance has occurred. Utility clearance for these six Upland Meadows sampling locations included contacting Underground Service Alert informing them that digging would occur and obtaining a dig ticket (#431296), as well as contracting a third-party underground utility locator, Precision Locating, to identify any underground utilities in the vicinity of the proposed sampling locations using electromagnetic field (EMF) detectors. Tetra Tech accompanied the utility locator, identifying the sampling locations (previously located and staked), as well as providing existing utility maps to mark known utility locations. Once an underground utility was detected, its estimated location and bearing were marked once the ground surface with spray paint. In cases where a utility was within 3 feet of a sampling location, the sampling location was moved slightly to maintain a safe distance (5 feet) from the utility.

Although surface disturbance has occurred in much of the Upland Meadows, the subsurface remains undisturbed in most areas, and therefore utility clearance was not conducted on the remaining 36 Upland Meadows locations.

The magnetic anomaly and BAPB area piezometer locations are in the Transition Area and Western Stege Marsh where the only utilities are the Eastern and Western Storm Drain lines and the City of Richmond sanitary sewer main, which are not within the sampling areas. Therefore, utility clearance was not required or conducted.

2.2 HAND AUGERING AND SOIL SAMPLING IN THE UPLAND MEADOWS

The Upland Meadows soil investigation was conducted in two phases. In the initial investigation phase, soil samples in the Upland Meadows were collected along 125-foot-spaced grids. Samples were collected from 0 to 0.5 feet bgs at all locations on the 125- foot by 125-foot grid spacing and 1.5 to 2 feet bgs at half of the total number of locations, on an approximately 125-foot x 250-foot grid spacing, as shown on Figure 6. This sampling grid was designed to assess any impacts from historical site use. Sampling of locations UM01 through UM42 occurred on October 20 and 22, 2014.

Based on PCB results exceeding and nearly exceeding the TSCA criterion of 1 mg/kg at locations UM33 (4.8 mg/kg total Aroclors) and UM36 (0.69 mg/kg total Aroclors), DTSC recommended that supplementary sampling be conducted to further characterize the potential distribution of PCBs in shallow

soil in the east and west portions of the EPA Meadow North. Supplementary sampling occurred on September 8, 2015. The sampling depth intervals selected were based on current topography in the EPA Meadow North; the east and west sides of the meadow are approximately 1 to 3 feet higher than the middle portion due to soil staging in those locations during the construction of the EPA Laboratory building in 1991 located south of the EPA Meadow. Soil samples were collected from 0 to 0.5 feet bgs and 1.5 to 2 feet bgs from six locations (UM43 to UM48). In addition, due to variations in topography, an additional soil sample was collected from 2.5 to 3 feet bgs at location UM47, from only 0 to 0.5 feet bgs at location UM49, and from 0 to 0.5 feet bgs and at 1 foot bgs at locations UM50 and UM51, as shown on Figure 6.

All samples collected as part of the Upland Meadows field investigation were collected in accordance with the QAPP (Tetra Tech 2010). For the initial field investigation, Tetra Tech contracted with Cascade Drilling, L.P. to complete sampling using hand augers at 42 locations from 0 to 0.5 feet bgs, and 21 of those locations from 1.5 to 2 feet bgs. Triplicate quality control (QC) samples were collected at locations UM04 and UM30 from 0 to 0.5 and 1.5 to 2 feet bgs, and at locations UM19 and UM28 from 0 to 0.5 feet bgs. A representative soil sample was collected from each depth interval. Soil from the designated depth interval was placed into a Ziploc bag for temporary storage then transferred into the sampling container appropriate for each analysis within 5 minutes of sample collection. For the supplementary PCB investigation, a bobcat vehicle with an auger attachment was used to loosen the soil for the top sample and used to arrive at the bottom sample depth for the deeper sample. At each sample depth interval, a disposable plastic scoop was used to collect the soil sample and place it directly into the sample jar.

At each sampling location, the hand auger or auger attachment was decontaminated using dry brushes before collection of the surface sample, and again when the top of the second sample was reached, if applicable, to reduce possibility of cross contamination between sampling depths. Only the amount necessary for the sample was collected from the entire length of the horizon; the rest of the plug was replaced to maintain the integrity of the valuable top 6 inches of the coastal terrace prairie soil.

All samples collected during the initial investigation were submitted to Curtis and Tompkins Laboratory in Berkeley, California for analysis of metals, PCBs, polycyclic aromatic hydrocarbons (PAH), and VOCs. Samples collected from 0 to 0.5 feet bgs from six locations near buildings or roads (UM01, UM03, UM09, UM20, UM28, and UM40) were analyzed for pesticides as well. In addition, triplicate samples were collected at six sample locations selected randomly in order to evaluate the confidence associated with representing soil conditions within a very short distance (2 feet). Soil samples collected during the supplementary PCB investigation were submitted to the sample laboratory for analysis of PCBs only. Soil sampling activities were conducted in accordance with the FSW (Tetra Tech 2010).

Soil samples collected for analysis of metals, pesticides, PCBs, and PAHs were placed directly into clean glass jars provided by the laboratory. Soil samples collected for VOC analysis were collected using Encore samplers consistent with EPA Method 5035. Following collection, all samples were labeled, wrapped with protective bubble wrap material and placed into a cooler with ice to maintain a temperature at or below 4° Celsius. The coolers were transported via car at the end of each day to Curtis and Tompkins Laboratory, where they were placed in freezers to preserve the samples. A copy of complete analytical results are presented in Appendix A, chain-of-custody forms are presented in Attachment 4, and the laboratory report is presented in Attachment 1.

Protection of Native Plant Species

Native plant species are present in the Upland Meadows soil and passive soil gas sampling areas. Consequently, no vehicles were used and sample locations were biased toward locations not occupied by

native plants to minimize impacts on the grasslands. In addition, all activities in the Upland Meadows adhered to the requirements of the Coastal Terrace Prairie Management Plan (Appendix G of the RBC Environmental Impact Report [Tetra Tech 2014a]).

2.3 EXPLORATORY EXCAVATION IN THE BULB

Multiple pre-excavation sampling activities were conducted within the Bulb in order to ensure worker safety and determine air monitoring chemicals of concern. Once results of the pre-excavation sampling activities were received and UC obtained confirmation that conditions were safe to work in, the exploratory excavation was conducted. This section summarizes pre-excavation and excavation activities in the Bulb. Sampling reports and results for this investigation are provided in Attachments 5 through 7. The California Department of Public Health, Radiologic Health Branch (CDPB-RHB) was contacted and provided review and consultation of the work plan. The pre-excavation and excavation activities are described in full in the Final Completion Report, Exploratory Excavation for Magnetic Anomaly Source in Bulb (Completion Report), by Cabrera Services, Inc., presented in Attachment 8.

2.3.1 Pre-Excavation Activities

Pre-excavation activities include the following sampling events, which are summarized below.

- Bulb Composite Soil Sampling Results for Determination of Air Chemicals of Concern
- DTSC October 2014 Magnetic Anomaly Survey of the Bulb
- Bulb1 and Bulb2 Groundwater Sampling Results

Soil sampling was conducted on July 24, 2014, to establish chemicals to be considered for air monitoring during the excavation activities. The composite sample was collected from the soil cuttings from eight boreholes randomly spaced throughout the proposed excavation boundary. The boreholes were advanced until the Bay Mud layer was encountered at approximately 4 feet bgs. Soils encountered in the boreholes consisted of loosely-compacted sand, silty sand, and gravely fill material above the Bay Mud. Traces of pyrite cinders were identified at the fill material/Bay Mud interface. The soil sample was collected from various depths to best represent soil and fill material that may be excavated during the exploratory excavation. Soil was not collected from below the Bay Mud interface because of low potential for the silty-clayey Bay Mud to become airborne. The soil sample was analyzed for semivolatile organic compound (SVOC), metals, pesticides, PCBs, and VOCs. Results indicate a concentration of 5.7 milligrams per kilogram (mg/kg) for Aroclor-1248, which exceed the Toxic Substances Control Act (TSCA) PCB criteria of 1 mg/kg for high occupancy areas that was used as the screening criteria for PCBs for this investigation. All concentrations of metals, pesticides, and SVOCs were below applicable screening criteria. Results are presented in Attachment 5.

In support of the July 24, 2014, soil sampling event, a UC Office of Environment, Health & Safety (EH&S) Radiation Safety Division Health Physicist conducted a radiation survey during the field activities, since the source of the magnetic anomaly could potentially include radioactive ore rocks as described in the allegations of buried drums. The radiation survey was performed using a Canberra InSpector 1000 (S/N 02084500) with a 1.5- by 1.5-inch LaBr IPROL-1 probe (S/N 04074637) (LaBr probe) to detect gamma rays at energies ranging from 30 kiloelectron volts to 3.0 megaelectron volts. The high resolution is excellent for nuclide identification while retaining a high efficiency. The LaBr probe was lowered down each borehole to monitor for increasing levels of radioactivity that might indicate presence of buried radioactive material. The average background reading at the surface was

approximately 10 microrems per hour (µrem/hr), and the probe's reading increased to approximately 13-15 µrem/hr when lowered into the boreholes. The EH&S Health Physicist determined that the increase was likely due to the increased geometry of detecting naturally occurring activity in the soil or concrete. An exposed piece of concrete pipe was also surveyed and exhibited no elevated level of exposure. A summary of the radiological safety survey is included as Attachment 2 of the Phase IV FSP (Tetra Tech 2014c).

On September 30, 2014, the Sacramento Geological Services Unit (GSU) of DTSC completed a magnetometer survey in the Bulb to confirm previous results from the 2006 magnetometer survey. The 2014 survey confirmed the occurrence and location of the anomaly reported in 2006. The GSU concluded that the center of mass of a ferrous metallic object (or objects) was located in the subsurface at the location identified previously. Attachment 6 documents the magnetometer survey.

On October 6, 2014, Tetra Tech collected groundwater samples from two existing monitoring piezometers (Bulb1 and Bulb2) in the general area of the planned excavation. Groundwater samples were submitted to Eberline Analytical Laboratory in Oak Ridge, TN, and analyzed for gross alpha-beta and gamma spectroscopy, as well as isotopic uranium. The UC Berkeley EH&S Radiation Safety Officer and the consulting health physicist from Cabrera reviewed the Eberline Analytical groundwater sampling results and concluded that the groundwater sample results were not significantly above natural background levels for radionuclides. Results for the laboratory analyses are presented in Attachment 7.

2.3.2 Exploratory Excavation Activities

On October 27 and 28, 2014, all equipment and material required to conduct the exploratory excavation were mobilized to the Site. As part of preparation for the excavation activities, RFS facilities staff performed mowing and grubbing of the area in early October. Work zones, including an exclusion zone and support zone, were established to isolate exploratory activities from adjacent non-work areas using temporary metal fencing and caution tape.

The exploratory investigation, conducted by Cabrera on October 29, 2014, consisted of two excavation trenches 20 feet long and 6 feet wide with approximate depths of 15 feet (see Figure 4 of Attachment 8). Radiological and geophysical surveys were conducted before conducting the excavation, as discussed below. The methodology, instrumentation, and results of the radiological and geophysical surveys are presented in Section 3.2 and Appendix A of the Completion Report (Attachment 8). Each trench was located within the estimated footprint of the magnetic anomaly area, and was excavated at depth intervals of 2 feet and surveyed with a radiological meter, photoionization detector (PID), and a magnetometer to evaluate subsurface conditions. All exploratory subsurface activities were performed during low tide events to minimize tidally-influenced groundwater infiltration into the excavated trenches.

2.3.2.1 Excavation, Observations, and Backfill

Before exploratory excavation work began at the site, preliminary surface radiological and geophysical surveys were conducted to assess the work areas and identify any metal debris below the ground surface. Once existing conditions were established, an excavator was used to dig two different trenches down to a maximum depth of 15 feet bgs beginning in the center of the strongest part of the anomaly. Two-foot lifts of soil were removed at a time and stockpiled on 10-mil plastic in order to conduct radiological surveys and VOC and hydrogen sulfide (H_2S) monitoring.

After each two-foot layer was removed, remote radiological and geophysical surveys were performed of the exposed excavation sidewalls and bottoms by technicians standing in a man lift basket positioned over the center of the excavation at a height of 2 feet above the surrounding ground surface. The exposed excavation sidewalls and bottoms were surveyed by suspending the hand-held meters above the excavation bottom surface with a telescopic handle; the newly exposed areas were slowly surveyed. Soil and debris excavated from the trenches from depths of 4, 6, and 12 feet bgs in Trench 1 and from 4, 6, 9, and 12 feet bgs in Trench 2 were also surveyed in the buckets and on the lay down pads using radiological instrumentation. Remote geophysical surveys were also performed by suspending geophysical instruments from a man lift basket positioned over the center of the excavation; these surveys were performed from depths of 0, 2, 4, 6, 9, 12, and 15 feet bgs in Trench 1 and from 4, 5.4, 8, 10, and 15 feet bgs in Trench 2. The readings at 15 feet in both trenches indicated that no metal was detected at the edges or bottom of either trench.

Groundwater that entered the excavation was pumped out as needed into an on-site fractionation tank, and later into two 275-gallon totes. See Section 3.8 of the Completion Report in Attachment 8 for additional details and supporting documentation.

A large metal and cement-filled cylindrical building anchor, known as a "deadman" anchor (approximately 6 feet long) was encountered at a depth of 6 feet bgs in the first trench excavated along with other concrete and metal construction demolition debris (see photo #21 of the Cabrera Photo Log, and slide # 8 of the second UC Berkeley Photo Log that are provided in Appendix F of Attachment 8). Numerous sections of large metal pipes and items such as metal lamp posts set in concrete, as well as reinforced concrete reinforced general metal debris, were also encountered (see photos #12, 24, and 34 of the Cabrera Photo Log, and slides #14 and 15 of the second UC Berkeley Photo Log that are provided in Appendix F of Attachment 8). Visual observations of the trench edges confirmed that at 15 feet bgs, both trenches were well within undisturbed Bay Mud; based on results of the field observations and field screening results, UC Berkeley and DTSC staff concurred that the excavation activities could be concluded.

Based on the information collected and the debris encountered, Cabrera, with concurrence from project stakeholders on-site including UC Berkeley, DTSC, and CDPB-RHB, concluded that the large concrete and metal anchor was the source of the metal anomaly.

The trenches were backfilled and the site was restored to pre-construction conditions on the same day. The trenches were backfilled using the stockpiled soil and debris material after placing poly sheeting on the bottom of the trenches to demarcate the depth of the excavations. The large metal "deadman" anchor was placed in near surface soil in order to easily locate it in the future. Disturbed areas were graded to pre-construction conditions. Fencing, barricades, and caution tape demarking the work areas were removed, and straw wattles were placed around the perimeter of the excavation to prevent runoff of soil erosion from the excavation area.

There were no elevated VOC or H_2S readings observed during trench excavation activities. Soil samples were not collected for analytical laboratory analysis during the exploratory investigation because of the lack of elevated field-screening results or visual observations suggesting sampling was necessary. The elevated magnetometer and metal detector detections in the excavation area were determined to be due to the metal anchor and miscellaneous concrete, metal, and construction debris in the two trench locations. No drums were encountered.

2.3.2.2 Post-Radiological Survey

Once the exploratory trenches were completed and backfilled, a final gamma walkover survey was performed of the backfilled trench areas to provide "as left" gross gamma conditions as a result of excavation activities. In no case did radiological results exceed the action levels for the project. The gamma walkover survey indicated that no further investigation was warranted and the measured radiological levels were not significantly greater than those measured in the pre-excavation radiological survey; therefore it was determined the area was not radiologically impacted by site activities.

2.3.2.3 Air Monitoring

Real-time dust (total particulate) and air monitoring for VOCs, H_2S, and airborne particulate alpha/beta and gamma radiation were performed to evaluate health and safety conditions and monitor potential off-site migration of contaminants from dust-generating activities. Real-time air monitoring was performed continuously in the workers' breathing zone and general work area to assess health and safety conditions during the investigation using a Dustrak instrument (for dust), a PID (for VOCs), an H_2S meter, and a breathing zone air sampler (for alpha/beta radiation). In addition, a Bicron Microrem was utilized to monitor work-zone areas for gamma radiation dose rate. Dust monitoring was also performed at the perimeter of the excavations to assess potential public health exposure to contaminants of concern, particularly Aroclor-1248, using Personal DataRAMs. In addition, perimeter air monitoring for alpha/beta radiation was conducted using high-volume air samplers. None of the field-measurements exceeded any of the limits set for breathing zone or perimeter air monitoring. The methodology, instrumentation, and results of these air monitoring surveys are presented in Section 3.9 and Appendix B of the Completion Report (Attachment 8).

2.3.2.4 Biological Monitoring for Ridgway's Rail and Shorebird Disturbance

A biological monitor was present during the exploratory excavation in the Bulb to observe and monitor for the Ridgway's Rail and disturbance to other shorebirds within and around the Western Stege Marsh. Shorebirds present during investigation activities did not show any signs of disturbance and no Ridgway's Rail individuals were observed.

2.4 PASSIVE SOIL GAS SAMPLING IN THE CARBON TETRACHLORIDE AREA

Passive soil gas samplers were installed at 32 locations within a grid centered on piezometer CTP in the Big Meadow (see Figure 7). In addition, triplicate samples were collected at three sample locations selected randomly in order to evaluate the confidence associated with representing soil gas conditions within a very short distance (3 feet). The soil gas investigation was conducted using Amplified Geochemical Imaging (AGI) Universal Samplers, a passive soil gas sampling technique. On October 21, 2014, the AGI Universal Samplers were installed by using a 0.5-inch rotodrill to drill to 3 feet bgs, and then installing the sampler at the bottom of the hole with a long metal rod provided by the manufacturer. Prior to installing the sampler, it was attached to a string approximately 3 feet long with a 1-inch diameter cork; the string enabled easy retrieval and the cork plugged the hole at the surface to prevent surface air intrusion. Samplers were left in place for 9 days. The locations were flagged and clearly labelled for retrieval.

On October 30, 2014, the AGI Universal Sampler was retrieved by pulling the cork placed at the soil surface, which pulled out the sampler attached to the string. The samplers were placed into the same

plastic jars they were distributed in, and a custody seal was placed on each jar. The samples were sent to the manufacturer for analysis of VOCs by EPA Method 8020. Borings were backfilled with soil removed during installation. A copy of complete analytical results are presented in Appendix B, the chain-of-custody form is presented in Attachment 4, and the laboratory report is presented in Attachment 2.

2.5 PIEZOMETER INSTALLATION IN THE BAPB AREA

Four piezometers were installed, developed, and sampled in the BAPB Area from January 28 through February 2, 2015. The sections below describe each of these activities.

2.5.1 Piezometer Installation

On January 28, 2015, three 2-inch piezometers were installed along the border of the ETA and one 2-inch piezometer was installed at the upgradient edge of the remediated portion of the Western Stege Marsh and west of the BAPB. The locations are presented on Figures 9 through 12). A light-weight direct push technology (DPT) and hollow stem auger (HSA) rig was mobilized to the BAPB area to install the piezometers. While nearly 13 inches of rain occurred in December 2014, the SF Bay Area received no precipitation in January 2015, resulting in firm and stable marsh edge soils that were considered safe for a drill rig to access without rutting or causing significant damage to restored vegetation. Piezometer locations were moved slightly from proposed locations to minimize impacts to native plant species. Before drilling began, the depth to groundwater at existing nearby piezometer ETA was measured to estimate the groundwater level at the four new piezometers and this data was considered during the determination of the screening interval.

Soil from each boring was first collected in an acetate sleeve to log soil types for site lithology characterization, to select depths of the screened interval for each piezometer, and to screen soil for VOCs. Pyrite cinders were observed at two boreholes in the eastern portion of the ETA: in the soil cores at locations ETA02 and ETA03 from 11 to 11.5 feet bgs. The boring logs are presented in Attachment 9. The screening interval at these two locations was selected to be below the depth of the pyrite cinders and within the shallow water-bearing zone – from 15 to 20 feet bgs. Pyrite cinders were not observed at ETA01 or WSM01 and these piezometers were screened from 5 to 15 feet bgs. A small amount of soil from every 2 feet of core was placed into a plastic bag and screened for VOCs using a PID and results were recorded directly onto the boring log for each piezometer.

Using the HSA, the piezometers were constructed from 2-inch diameter schedule 40 polyvinyl chloride (PVC) blank casing with 2-inch diameter schedule 40 PVC screen with 0.01-inch slot size. The screen intervals of the piezometers were encased in a filter pack consisting of #2/12 kiln-fired sands that were tremied into place through the HSA. The filter pack extended from the bottom of the boring to 1 foot above the top of the PVC screen where a 2-foot-thick seal of hydrated bentonite chips was installed. The remainder of the boring surrounding the PVC casing was filled with an annular seal of Portland cement grout to within 1 foot of the ground surface. WSM01 was finished 2.5 feet above grade and was surrounded with a steel stove-pipe stickup that protrudes 3 feet above the sediment surface. ETA01, ETA02, and ETA03 were finished a few inches above grade, and completed with steel well Christy boxes. The above grade casings were encased in a 2-foot by 2-foot concrete pad to protect the piezometers from accidental damage. A locking well cap, to prevent rain or irrigation water from entering the piezometers, was placed on each piezometer.

2.5.2 Piezometer Development

The piezometers were allowed to stabilize for 48 hours before development began on January 30, 2015, to ensure that the bentonite and annular seals had set. The piezometers were surged for a minimum of 10 minutes using a surge block and pulley system that forces water into and out of the filter pack. Water from the piezometers was then pumped out to remove excessive sediments from the standing water in the piezometer casings. The discharge water from the pump was analyzed using a water quality meter that measured groundwater turbidity, temperature, pH, and specific conductance. At least three times the volume of water within the filter pack and piezometer casing was purged during development. Well development data sheets are presented in Attachment 9. Completion information for each piezometer is presented in Table 2.

2.5.3 Groundwater Sampling

Groundwater samples were collected on February 2, 2015, through sterile silicon tubing using a low-flow peristaltic pump. The discharge from the pump ran through a flow cell that measured pH, temperature, specific conductance, turbidity, dissolved oxygen, total dissolved solids, salinity, and oxidation-reduction potential. Groundwater samples were collected from each piezometer after the parameters stabilized to within the acceptable ranges, as shown on the groundwater sample collection sheets included in Attachment 9 and summarized in Table 3. The flow-through cell was disconnected from the sampling system prior to sample collection. Groundwater results are discussed in Section 4.0.

Groundwater samples were submitted to the laboratory for analysis of dissolved metals and VOCs. Samples were immediately placed in coolers containing ice. At the end of each day, the samples were delivered to Curtis and Tompkins laboratory located in Berkeley, California, using chain-of-custody procedures. A copy of complete analytical results are presented in Appendix C, the chain-of-custody forms are presented in Attachment 4, and the laboratory report is presented in Attachment 3.

Water level measurements were collected from the new wells and all other shallow horizon piezometers at RFS and at the Campus Bay Property on April 1, 2015. The resulting groundwater contours are presented on Figure 12.

2.5.4 Permits and Permit Compliance

UC Berkeley consulted all relevant regulatory agencies, and obtained applicable permits to conduct the BAPB piezometer installation, as summarized below.

Title	Agency	Permit No.
San Francisco Bay Conservation and Development Commission (BCDC) Permit	BCDC	Amendment No. Three to existing Regionwide 2, Permit No. M01-52(b), dated June 27, 2002
Clean Water Act 404 Nationwide Permit 5 for Scientific Measurement, 77 Fed. Reg. 10,184 (February 21, 2012)	U.S. Army Corps of Engineers (USACE)	File No. 2003-281350S

Title	Agency	Permit No.
Clean Water Act 401 Water Quality Certification of 2012 Nationwide Permit	San Francisco Bay Regional Water Quality Control Board (RWQCB)	UC Berkeley/RFS Piezometer 401 Certification 2015, under USACE Nationwide Permit (NWP) No. 5
California Endangered Species Act	California Department of Fish and Wildlife (CDFW)	Not Applicable – no permit required
Biological Opinion (BO)	U.S. Department of Fish and Wildlife (USFWS)	BO 1-1-F-03-0228 (granted continuation of 2003 BO)

As the project disturbed less than one acre of soil, UC Berkeley was not required to obtain coverage under the General Permit for Discharges of Storm Water Associated with Construction Activity (Construction General Permit, No. 2009-0009-DWQ as Modified by 2010-0014-DWQ), and a project-specific Storm Water Pollution Prevention Plan was not required.

Pursuant to the RWQCB water quality certification, a light-weight track rig was used to install all piezometers in the BAPB area to avoid compaction of soils, tire ruts and marks, and permanent loss of vegetative cover. Appendix D presents photographs of pre-installation, during installation, and post-installation conditions of the marsh piezometer (WSM01) location and the access route for vehicles used during the installation, as required by the RWQCB permit. All drilling fluid and mud were contained and hauled off-site for disposal, with no resulting discharge to the wetland or ecotone area.

In addition, pursuant to the RWQCB permit and BO, a biological monitor was present during the installation and development of the four BAPB area piezometers to observe and monitor for the Ridgway's Rail and potential disturbance to other shorebirds within and around Western Stege Marsh. During development of piezometer ETA01 on January 30, 2015, one Ridgway's Rail was observed in the remediated portion of the marsh in the location presented in Figure E-1 of Appendix E. The bird walked onto the mud flats and sunned itself for a few minutes, then returned into the vegetation. The bird did not show any signs of disturbance by the piezometer installation or development activities. Other shorebirds present during investigation activities also did not show any signs of disturbance. Appendix E presents photographs of the biological monitor and of the observed Ridgway's Rail.

2.6 WASTE CHARACTERIZATION AND DISPOSAL

Investigation-derived waste (IDW) created during the field effort included:

- One 5-gallon plastic bucket of soil from the Upland Meadows
- Five 55-gallon drums of soil cuttings from BAPB piezometer installation
- Eight 55-gallon drums of development water, purge water, and decontamination water from BAPB well development and sampling activities
- Two 275-gallon totes containing approximately 500 gallons of groundwater pumped out of the exploratory excavation of the magnetic anomaly in the Bulb
- Incidental waste such as personal protective equipment and plastic sheeting

All IDW was labeled and moved to a fenced storage location west of Building 110.

The drums of BAPB soil cuttings were characterized by collecting one 60-point sample created by compositing small amounts of soil from 15 points from each of the four continuous cores obtained using the direct-push rig; the sample was analyzed for metals only. In addition, one 3-point Encore sample was created by collecting soil from three points between 15 and 20 feet bgs of the continuous core obtained at piezometer location ETA03. The laboratory was instructed to composite the sample by preserving each Encore sampler in methanol. The composited sample was analyzed for VOCs only. Analytical results characterize the soil as non-hazardous. Based on comparison of the Upland Meadows sampling results with the Category I on-site management criteria specified in the Remedial Action Workplan (RAW) (Tetra Tech 2014b), only manganese exceeds the criteria. Manganese concentrations exceed the Category I criteria in the majority of samples collected throughout the Site, and given the lack of known or suspected source of manganese, the concentrations likely represent ambient soil conditions. Consequently, the soil IDW is suitable to be reused within the project study area, or as approved by DTSC, and the soil will be proposed for re-use within the study area in a separate notification to DTSC.

The drums of BAPB development water and purge water were characterized using the results of the groundwater samples collected on February 2, 2015. These drums will be disposed of at a licensed off-site disposal facility as non-hazardous waste along with purgewater and rinsewater collected during April 2015 groundwater monitoring.

The two totes of groundwater pumped from the Bulb exploratory excavation were characterized by collecting one sample from the groundwater, which was characterized as non-hazardous. Analytical results of this sample are presented in Appendix C of the Completion Report (Attachment 8). The two totes were removed from the storage location on January 15, 2015 and shipped to the Clean Harbors Grassy Mountain facility for off-site disposal.

Incidental waste such as personal protective equipment and plastic sheeting was collected, containerized, and disposed of as trash by UC Berkeley.

3.0 DATA QUALITY ASSESSMENT

This section discusses the DQOs developed during the FSW planning process, as well as the assessment of laboratory data received. It also discusses deviations from the Phase IV FSP (Tetra Tech 2014c).

3.1 DATA QUALITY OBJECTIVES

DQOs were developed during the FSW planning process to help ensure data appropriate to support defensible decisions was collected. Phase IV DQOs are presented in the Phase IV FSP Section 3.0 (Tetra Tech 2014c).

Upland Meadows Soil Sampling: The DQOs stated the need for soil data from shallow soils in the Upland Meadows to determine if chemicals are present a concentrations that pose unacceptable risks to human health or the environment. This objective was achieved through the placement of shallow (0 to 0.5 feet bgs) soil sampling locations on a 125-foot x 125-foot grid within the Upland Meadows, and subsurface (1.5 to 2.0 feet bgs) soil sampling locations on a 125-foot x 250-foot grid. Sample locations were chosen to provide broad coverage of the Upland Meadows – an area where no known contaminant source exists. The supplementary PCB sample locations at the EPA Meadow North were selected based on review of the initial PCB sample results from the grid locations. The chemical data collected improves the overall site knowledge of chemical concentrations in the Upland Meadows.

Exploratory Excavation to Investigate the Magnetic Anomaly: The DQOs stated the need to identify the source of the magnetic anomaly in the southwest corner of the Bulb, and to determine if radioactive or chemical contamination are present. This objective was achieved through excavation of surface and subsurface soils in the magnetic anomaly area until the magnetic source was discovered, as well as continual radiation monitoring and collection of soil samples, if warranted.

Carbon Tetrachloride Source Investigation: The DQOs stated the need for shallow soil gas data to improve understanding of a potential carbon tetrachloride source. This objective was achieved through placement of soil gas sampling locations on an approximate 60-foot by 60-foot grid, with a tighter 30-foot by 30-foot grid in the area immediately adjacent to piezometer CTP. Piezometer CTP has consistently shown low concentrations of carbon tetrachloride. Sample locations were selected to focus on the area where carbon tetrachloride has been detected in groundwater, and expand outward to attempt to find a groundwater contaminant source.

BAPB Area Groundwater: The DQOs stated the need to characterize metals and VOCs in shallow groundwater upgradient and crossgradient of the BAPB, and to determine the need to conduct annual monitoring in the area. This objective was achieved through the installation and development of four piezometers to depths of 15 or 20 feet bgs, followed by collection of groundwater samples using low-flow sampling methods.

All work was conducted according to the methods described in the sampling plan and QAPP in the FSW (Tetra Tech 2010) and Phase IV FSP (Tetra Tech 2014c). The analytical data from the Upland Meadows soil samples and BAPB-area groundwater samples achieved appropriate method detection limits (MDL) to be compared with relevant human health soil criteria, ecological soil criteria, or ambient water quality criteria, as applicable. This is discussed further in Section 4.0. Results from the passive soil gas samples were not intended for use in a human health or ecological risk evaluation, only to help identify possible sources.

3.2 LABORATORY DATA REVIEW

Assignment of data qualification flags for analytical data from Curtis and Tompkins conformed to EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA 2008) and Inorganic Data Review (EPA 2010b). Data review specifications require that various data qualifiers be assigned when a deficiency is detected or when a result is less than its detection limit. If no qualifier is assigned to a result that has been reviewed, the data user is assured that no technical deficiencies were identified during validation. The qualification flags used are defined as follows:

- U – Indicates that the chemical was not detected at the numerical detection limit (sample-specific detection limit) noted. Non-detected results from the laboratory are reported in this manner.
- UJ – Indicates that the chemical was not detected; however, the detection limit (sample-specific detection limit) is considered estimated based on problems encountered during laboratory analysis. The associated numerical detection limit is regarded as inaccurate or imprecise. This qualifier is also added to a positive result (reported by the laboratory) if the detected concentration is determined to be attributable to contamination introduced during field sampling or laboratory analysis.
- J – Indicates that the chemical was detected; however, the associated numerical result is not a precise representation of the concentration that is actually present in the sample. The laboratory-reported concentration is considered an estimate of the true concentration.
- R – Indicates that the chemical may or may not be present, and that the data was rejected. The non-detected analytical result reported by the laboratory is considered unreliable and unusable. This qualifier is applied in cases of gross technical deficiencies (for example, a holding time missed by a factor of two times the specified time limit, severe calibration non-compliance, or extremely low analyte recovery in QC spike samples).

The preceding data qualifiers may be categorized as indicating major or minor problems. Major problems are defined as issues that result in the rejection of data and qualification with R. These data are considered invalid and are not used for decision-making purposes unless they are used in a qualitative way and the use is justified and documented. Minor problems are defined as issues resulting in the estimation of data and qualification with U, J, and UJ qualifiers. Estimated analytical results are considered suitable for decision-making purposes unless the data use requirements are stringent and the qualifier indicates a deficiency that is incompatible with the intended data use. A U qualifier does not indicate that a data deficiency exists because all non-detect values are flagged with the U qualifier regardless of whether a quality deficiency has been detected.

3.3 DATA QUALITY REVIEW FINDINGS

The following section addresses quality review findings for the inorganic and organic Upland Meadows data collected in October 2014, the supplementary PCB Upland Meadows data collected in September 2015, and the inorganic and organic data collected in the BAPB in February 2015.

The data collected as part of the Phase IV sampling investigation meet all the requirements of the precision, accuracy, representativeness, completeness, and comparability described in EPA guidance for quality assurance project plans (EPA 2002) and the QAPP (Appendix A of Tetra Tech 2010), and are usable for meeting the project DQOs and future risk assessments. The overall assessment of the sampling

program, QA/QC data, and data review indicates the data from this investigation are of acceptable precision, accuracy, representativeness, completeness, and comparability.

A review of the Upland Meadow inorganic data quality determined that quality assurance (QA)/QC objectives for bias and precision were met for the analytical results, with the following exceptions:

- Matrix spike/matrix spike duplicate (MS/MSD) and laboratory control sample (LCS) spike recoveries resulted in qualification of results as estimated ("J") for cobalt and vanadium in one sample (UM1801), lead in two samples (UM1801, UM2801-R3), calcium, magnesium, and nickel in one sample (UM2501), and mercury in one sample (UM2801-R3). Less than 1 percent of all the inorganic Upland Meadows data were qualified as a result of these criteria violations.
- As a result of high relative percent difference between the MS and MSD, cobalt was qualified as estimated ("J") in sample UM2501.
- Serial dilution criteria violations resulted in qualification of results as estimated ("J") for magnesium in two samples (UM0801, UM1801), nickel in three samples (UM0801, UM1801, UM2801-R3), potassium in two samples (UM0801, UM2801-R3), and copper, cobalt, iron, manganese, vanadium, and chromium in one sample (UM2801-R3). Less than 1 percent of all the inorganic Upland Meadows data were qualified as a result of these criteria violations.
- Several inorganic sample results were "J" qualified as estimated because they were reported at concentrations between the MDL and the laboratory quantitation limit (QL). The analytical instrument can make reliable qualitative identification of analyte concentrations above the MDL but below the QL. However, detected results below the QL are considered quantitatively uncertain. Approximately 19 percent of the inorganic data was affected; however, these results are considered usable as qualified.

A review of the Upland Meadow organic data quality determined that QA/QC objectives for bias and precision were met for analytical results, with the following exceptions:

- As a result of low response in the continuing calibration verification of the PAH, PCB, pesticide, and VOC analyses, results for the following samples were qualified as estimated ("J") based on calibration QC violations; less than 6 percent of all the Upland Meadow organic data were qualified as a result of this criteria violation.
    - PAHs: Forty two samples of 1,4-dioxane, 1-methylnaphthalene, 2-methylnaphthalene, and acenaphthalene (UM0301, UM0401, UM0401-R1, UM0401-R2, UM0402-R1, UM0402-R2, UM0402-R3, UM0501, UM0502, UM0601, UM0701, UM0702, UM0801, UM0901, UM1001, UM1002, UM1101, UM1201, UM1202, UM1301, UM1401, UM1402, UM1501, UM1601, UM1602, UM1701, UM1801, UM1802, UM1901-R1, UM1901-R2, UM1901-R3, UM2001, UM2101, UM2102, UM2201, UM2301, UM2302, UM2401, UM2501, UM2502, UM2901, UM2902).
    - PCBs: One sample of Aroclor-1254 (UM4703); Twenty five samples of Aroclor-1260 (UM0101, UM0201, UM0301, UM0401-R1, UM0401-R2, UM0401-R3, UM0501, UM0601, UM0701, UM0901, UM1001, UM1101, UM1201, UM1401, UM1602, UM1801, UM1901-R1, UM1901-R2, UM1901-R3, UM2001, UM2201, UM2401, UM2501, UM2901, UM2902, UM4701, UM4702, UM4703).

- Pesticides: Four samples of 4,4'-dichlorodiphenyldichloroethylene (DDE), 4,4'-dichlorodiphenyltrichloroethane (DDT), endosulfan II, and endrin aldehyde (UM2801-R1, UM2801-R2, U2801-R3,and UM4001)
- VOCs: Fifteen samples of tert-butyl alcohol (UM0102, UM0402-R1, UM0402-R2, UM0402-R3, UM0502, UM0702, UM1002, UM1202, UM1402, UM1602, UM1802, UM2102, UM2302, UM2502, UM2902) and 10 samples of methyl tert-amyl ether (UM0102, UM0402-R1, UM0402-R2, UM0402-R3, UM0502, UM0702, UM1002, UM1202, UM1402, UM1602).

- MS/MSD and LCS spike recoveries resulted in qualification of results as estimated ("J") for PAH fluoranthene in one sample (UM1201), benzo(b)fluoranthene in one sample (UM3401), as well as VOC acetone in three QC samples (RFS-P4-ER03, RFS-P4-SWB01, RFS-P4-TB01), and pesticide 4,4'-dichlorodiphenyldichloroethane (4,4'-DDD) in two QC samples (RFS-P4-ER03, RFS-P4-SWB01). Less than 0.2 percent of all the Upland Meadow organic data were qualified as a result of these criteria violations.
- As a result of laboratory blank contamination, the methylene chloride results in two QC samples (RFS-P4-TB01, RFS-P4-TB02) and acetone results in five QC samples (RFS-P4-ER01, RFS-P4-ER03, RFS-P4-SWB01, RFS-P4-TB01, RFS-P4-TB02) are considered non-detect and "UJ" qualified. In addition, due to field blank contamination, results for xylenes in two QC samples (RFS-P4-ER03, RFS-P4-SWB01) are considered non-detect and "UJ" qualified. Less than 0.3 percent of the Upland Meadow organic groundwater data were qualified as a result of laboratory and field blank contamination problems.
- Due to holding times violations, results for all the Aroclors in one sample (UM0401-R3) were "J" qualified as estimated.
- Due to surrogate recovery violations, results for all the Aroclors in one sample (UM1202) and five Aroclors in one sample (UM0401-R3) were "J" qualified as estimated.
- The results for several organic compounds in a few samples were estimated because they were reported at a concentration between the MDL and the QL. The analytical instrument can make reliable qualitative identification of analyte concentrations above the MDL but below the QL; however, detected results below the QL are considered quantitatively uncertain. Approximately 11 percent of the Upland Meadow organic data was affected.

A review of the BAPB inorganic data quality determined that QA/QC objectives for bias and precision were met for the analytical results, with the following exceptions:

- Due to calibration response violations, results for selenium in three samples (20150202ETA03GW01, 20150202ETA02GW01, 20150202ETA02GW01D) were "J" qualified as estimated.
- Several inorganic sample results were "J" qualified as estimated because they were reported at concentrations between the MDL and the laboratory QL. The analytical instrument can make reliable qualitative identification of analyte concentrations above the MDL but below the QL; however, detected results below the QL are considered quantitatively uncertain. Approximately 13.3 percent of the inorganic BAPB data was affected; however, these results are considered usable as qualified.

A review of the BAPB organic data quality determined that QA/QC objectives for bias and precision were met for analytical results, with the following exceptions:

- Due to calibration response violations, results for tert-butyl alcohol in all five samples (20150202ETA03GW01, 20150202ETA02GW01, 20150202ETA02GW01D, 20150202ETA01GW01, 20150202WSM01GW01) were "J" qualified as estimated.
- The results for several organic compounds in a few samples were estimated because they were reported at a concentration between the MDL and the QL. The analytical instrument can make reliable qualitative identification of analyte concentrations above the MDL but below the QL; however, detected results below the QL are considered quantitatively uncertain. Approximately 4 percent of the BAPB organic data was affected.

Although some qualifiers were added to the data, a final review of the dataset compared with EPA data quality parameters indicate that the data are of high overall quality. The data collected as part of the Phase IV sampling investigation meet all the requirements of the precision, accuracy, representativeness, completeness, and comparability described in EPA guidance for quality assurance project plans (EPA 2002) and the QAPP (Appendix A of Tetra Tech 2010), and are usable for meeting the project DQOs and future risk assessments. The overall assessment of the sampling program, QA/QC data, and data review indicates the data from this investigation are of acceptable precision, accuracy, representativeness, completeness, and comparability.

The following QC was verified by the laboratory for the carbon tetrachloride passive soil gas sampling results:

- A bromofluorobenzene tune was analyzed at the start of each analytical run and after every 30 samples.
- A minimum of a five-point calibration curve was analyzed prior to the analysis of samples.
- If the relative standard deviation (RSD) of any target analyte was less than or equal to 25 percent then average response factor was used for quantitation. If the RSD exceeded 25 percent for a target compound a regression equation was used for quantitation.
- After every 10 samples, and at the end of each analytical batch, a second-source reference standard was analyzed near the mid-point of the calibration curve. The acceptance criteria for all target analytes in the reference standards was +/- 50 percent of the true value.
- A method blank was analyzed prior to the analysis of field samples and every 30 samples.
- A trip blank was analyzed.

All criteria was met for the carbon tetrachloride passive soil gas sampling.

3.4 ANALYSIS OF TRIPLICATE SOIL SAMPLE DATA

The reproducibility of FSW sample data was also evaluated by comparing results from three field replicate samples collected in a triangular formation within 1.5 feet of each other at the following four locations selected at random: UM04 (0 to 0.5 feet bgs and 1.5 to 2 feet bgs), UM19 (0 to 0.5 feet bgs), UM28 (0 to 0.5 feet bgs), and UM30 (0 to 0.5 feet bgs and 1.5 to 2 feet bgs) (Figure 6). These six sets of samples were collected to evaluate variability of soil concentrations within small areas. For these field

replicate samples, the RSD was calculated to evaluate precision of the data. The RSD is the standard deviation divided by the mean of the three results. The RSD is also intended to quantify the total error of the measurement system and is used as a QC measure to assess sample variability. The RSD calculations for the Upper Meadows triplicate samples are presented in Table 4. All triplicate samples were analyzed for metals, PAHs, and VOCs; the sample collected from UM28 was also analyzed for pesticides.

Of the 237 triplicate results that had a detected result for at least one triplicate, the percent RSD could not be calculated for 38 triplicates because at least one of the three results was nondetect. Most of the data with incalculable RSDs were at concentrations near or below the quantitation limit, indicating precision difficulties at concentrations near quantitation limits. Of the remaining 199 triplicate results, thirty-two percent of the field replicate data had a high RSD (exceeding 30 percent to 35 percent; Interstate Technology Regulatory Council [ITRC] 2012). Of the results with high RSDs, over half were PAH results. Five of six RSDs for manganese were greater than 30 percent, indicating that levels of manganese in soil are highly variable in the Upland Meadows, even within close distances.

High RSD values for field replicates suggest a substantial degree of heterogeneity in the analyte concentrations. If the results are close enough to an action level that decision errors are possible, re-sampling with an increased number of discrete sample locations may be necessary to reduce error (ITRC 2012). However, in the Upland Meadows dataset, chemical concentrations with a high RSD are not close to action levels.

Field triplicates were also collected to provide information on sample precision and homogeneity. Co-located samples are expected to have the same or very similar chemical concentrations because they are so close spatially; however, co-located samples often do not meet precision expectations (ITRC 2012). An analysis of triplicate metals results in the Upland Meadows illustrates that naturally-occurring metals concentrations vary widely even when collected as close as 1.5 feet of each other. Appendix F provides a graphic presentation of metals results from each sample location in comparison with all sample location results. Triplicate sample results are called out specifically in Figures F-4, F-19, F-28, and F-30.

3.5 DEVIATIONS

The passive soil gas samplers were removed 9 days following installation instead of the proposed 10 days, because rain was forecast for the evening on the 9th day, October 30, 2014. Removal of the samplers prior to the onset of rain would minimize potential impacts to native species within the coastal terrace prairie without compromising the soil gas data results. This deviation did not affect the usability of the data or conclusions for the soil gas sampling activity.

The cap on one of the passive soil samplers was dropped and replaced with a cap from one of the trip blanks; therefore only one trip blank, rather than the intended two trip blanks, was analyzed. This deviation did not affect the usability of the data or conclusions for the soil gas sampling activity.

With the exception of minor changes in sample locations based on the utility clearance or minimizing impacts to native species, no other deviations to the work plan were observed.

4.0 DATA EVALUATION

This section provides an overview of the compounds detected during the soil sampling conducted in the Upland Meadows, passive soil gas sampling conducted in the carbon tetrachloride area, and groundwater sampling collected from the new piezometers installed in the BAPB area.

4.1 UPLAND MEADOWS SOIL SAMPLING RESULTS

All soil samples collected in the Upland Meadows were submitted for analysis of metals, PCBs, PAHs, and VOCs, and six soil samples were also submitted for analysis of pesticides. Table 5 provides a statistical summary of the analytes detected in the Upland Meadows soil compared with relevant human health and ecological screening criteria, including the calculation of the one-sided 95 percent upper confidence limit of the mean (95UCL). A comparison of site concentrations to human health and ecological screening criteria was used to determine if chemicals are present at concentrations that pose unacceptable risks to human health or the environment, or exceed background levels, where applicable.

Screening criteria for soil samples include human health and ecological screening criteria. Human health criteria include the criteria developed in the SCR for maintenance workers, who may be exposed to chemicals if utility corridors are installed, and for off-site receptors, who may be exposed to chemicals via the inhalation pathway during potential excavation activities (Tetra Tech 2013a). Ecological criteria include EPA's Ecological Soil Screening Levels (Eco-SSL) (EPA 2010a) for plants, invertebrates, birds, and mammals. If an Eco-SSL for plants in invertebrates is not available, Oak Ridge National Laboratory (ORNL) phytotoxicity and earthworm toxicity benchmarks were used (Efroymson and others 1997a, 1997b). Eco-SSLs are derived to be protective of the conservative end of the exposure and effects distribution, and are not designed to be used as cleanup levels (EPA 2003). ORNL benchmarks are intended to be thresholds for significant effects on growth and production (Efroymson and others 1997a, 1997b).

The results of a technical memorandum presenting an ambient metals evaluation for aluminum, cobalt, manganese, and nickel were incorporated into the evaluation of these four metals (Tetra Tech 2015). The technical memorandum presents ambient concentrations, which helps to ensure that investigation or cleanup efforts are not expended towards metals concentrations that are not associated with suspected contamination. The technical memorandum presents a statistical evaluation of site-collected metals data and presents a weight-of-evidence evaluation including discussion of chemical properties and uses, other relevant background studies and a literature review, which support the establishment of ambient concentrations at the former RFS site for these four metals.

Tables 6 to 10 provide results for detected analytes in Upland Meadows soil, also compared with relevant human health and ecological screening criteria. Sampling locations are presented on Figure 6. Complete analytical results are included in Appendix A and the laboratory report is included in Attachment 1. Appendix F provides a graphic presentation of metals results from each sample location in comparison with all sample location results.

4.1.1 Metals

The 75 samples collected were submitted for analysis of metals by EPA Methods 6020A and 7471A. Sampling results are presented in Table 6. All metals were detected.

The statistical summary of detected chemicals in the Upland Meadows is presented in Table 5. Results are presented in Tables 6 and 7. In addition, Appendix F presents scatter plots presenting the distribution of each metal (excluding essential nutrients) in the Upland Meadows soil samples, highlighting the result for each sample location by metal within the overall dataset. Screening criteria and ecological benchmarks are presented on each plot for purposes of comparison.

Concentrations of arsenic, cobalt, and manganese were detected at concentrations exceeding the human health maintenance worker or off-site receptor inhalation criteria in at least one sample. Concentrations of aluminum, antimony, arsenic, barium, cadmium, beryllium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, vanadium, and zinc exceeded ecological screening criteria in at least one sample. Concentrations of beryllium, silver, and thallium did not exceed any ecological criteria. There are no human health or ecological criteria for essential nutrients calcium, iron, magnesium, potassium, and sodium. Each metal that exceeded the corresponding human health screening criterion or ecological benchmark is discussed below. For chemicals where a criterion is exceeded and ambient values have been established, a discussion of ambient values is included as a line-of-evidence for evaluating whether the chemical should be considered a potential chemical of concern or represent contamination from site activities. Iron may be considered an essential nutrient and should not pose risk to either human or ecological receptors, therefore it is not evaluated below.

Aluminum. Aluminum was detected in all 75 samples with concentrations ranging from 8,500 to 28,000 mg/kg. All 75 results exceeded the plant ORNL benchmark of 50 mg/kg. There are no established benchmarks for invertebrates, birds, or mammals; however, the Eco-SSL guidance (EPS 2010) recommends that aluminum should only be considered a potential chemical of concern when pH in soil is less than 5.5. Although pH data for soil is not available for the Upland Meadows, soil pH is not expected to be below 5.5. Soil samples will be analyzed for pH in future events if analysis includes aluminum as a chemical of potential concern for ecological risks. Aluminum is not expected to pose risk to ecological receptors. The ambient metals evaluation determined that all detected concentrations of aluminum at the former RFS site are related to ambient conditions, and recommends that aluminum be eliminated from further consideration as a chemical of concern at the former RFS site (Tetra Tech 2015).

Antimony. Antimony was detected in all 75 samples with concentrations ranging from 0.13 to 4.5 mg/kg. No results exceeded the plant ORNL benchmark or the invertebrate Eco-SSL of 5 and 78 mg/kg, respectively. Fifty-three results exceed the mammalian Eco-SSL of 0.27 mg/kg. There is not an established benchmark for birds. Antimony does not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Arsenic. Arsenic was detected in all 75 samples with concentrations ranging from 3.5 to 51 mg/kg. One sampling result (UM41 from 0 to 0.5 feet bgs) exceeded background concentration of 16 mg/kg (Tetra Tech 2014b); elevated concentrations of arsenic and other metals in this sample are attributed to the presence of pyrite cinders observed within the sample. The sample was collected in a location associated with backfill in the City of Richmond sewer line that traverses the West Meadow. The same sampling result (UM41 from 0 to 0.5 feet bgs) exceeded the plant, bird, and mammal Eco-SSLs of 18, 43, and 46 mg/kg, respectively. None of the results exceeded the invertebrate ORNL benchmark of 60 mg/kg. Arsenic does not pose risk to human or ecological receptors. The arsenic concentration at UM41 is attributable to the observed pyrite cinders. Concentrations of arsenic at all other locations do not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Barium. Barium was detected in all 75 samples with concentrations ranging from 110 to 490 mg/kg. No results exceeded the plant ORNL benchmark or the mammalian Eco-SSL of 500 and 2,000 mg/kg, respectively. Two results, from the subsurface depth intervals of UM04 (420 mg/kg in one of three samples collected at this location) and UM39 (490 mg/kg), exceeded the invertebrate Eco-SSL benchmark of 330 mg/kg. There is not an established benchmark for birds. Barium does not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Cadmium. Cadmium was detected in 69 of 75 samples with concentrations ranging from 0.061 to 6.8 mg/kg. No results exceeded the plant or invertebrate Eco-SSL of 32 and 140 mg/kg respectively. Two results, from the surface depth interval of UM41 (6.8 mg/kg), and from the subsurface depth interval of UM25 (0.85 mg/kg) exceeded the invertebrate Eco-SSL of 0.77 mg/kg. Six results exceed the mammalian Eco-SSL of 0.36 mg/kg. The elevated concentration of cadmium in the surface sample at UM41 can be attributed to the presence of pyrite cinders, which were observed within the sample. Cadmium does not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Chromium. Chromium was detected in all 75 samples with concentrations ranging from 37 to 160 mg/kg. All 75 results exceeded the plant and invertebrate ORNL benchmarks of 1 and 0.4 mg/kg, respectively. The maximum detected concentration, from the surface depth interval of UM19-FR1 (in only one of three triplicate samples collected at this location and depth), exceeded the mammalian Eco-SSL of 130 mg/kg. There is not an established benchmark for birds. Chromium does not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Cobalt. Cobalt was detected in all 75 samples with concentrations ranging from 3.1 to 73 mg/kg. Cobalt exceeded the maintenance worker criterion of 34.1 mg/kg at three locations: UM04-FR3 from 1.5 to 2 feet bgs (in only one of three triplicate samples collected at this location and depth), UM28-FR1 from 0 to 0.5 feet bgs (in only one of three triplicate samples collected at this location and depth), and UM39 from 1.5 to 2.0 feet bgs. Thirty-two results exceeded the plant Eco-SSL of 13 mg/kg. None of the results exceeded the avian or mammalian Eco-SSLs of 120 and 230 mg/kg, respectively. There is not an established benchmark for invertebrates. The ambient metals evaluation concluded that detected concentrations of cobalt up to 73 mg/kg represent ambient concentrations and should not be considered for further evaluation (Tetra Tech 2015). Therefore, cobalt does not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Copper. Copper was detected in all 75 samples with concentrations ranging from 16 to 170 mg/kg. Three results, from the surface depth interval of UM36 (79 mg/kg), UM42 (74 mg/kg), and UM41 (170 mg/kg), exceeded the plant and mammalian Eco-SSLs of 70 and 49 mg/kg, respectively. The maximum result exceeded the invertebrate Eco-SSL of 80 mg/kg. Twenty-one sample results exceeded the avian Eco-SSL of 28 mg/kg. The elevated concentration of copper at UM41 can be attributed to the presence of pyrite cinders, which were observed within the sample. Copper does not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Lead. Lead was detected in all 75 samples with concentrations ranging from 5.7 to 89 mg/kg. No results exceeded the plant and invertebrate Eco-SSL of 120 and 1,700 mg/kg, respectively. Fifty-seven results exceed the avian Eco-SSL of 11 mg/kg. Three results, from the surface depth

interval of UM40 (89 mg/kg), UM41 (57 mg/kg), and UM41 (70 mg/kg), exceeded the mammalian Eco-SSL of 57 mg/kg. The elevated concentration of lead at UM41 can likely be attributed to the presence of pyrite cinders, which were observed within the sample. Lead does not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Manganese. Manganese was detected in all 75 samples with concentrations ranging from 120 to 5,900 mg/kg. The maximum concentration from location UM39 from 1.5 to 2 feet bgs exceeded the maintenance worker criterion of 5,300 mg/kg. All but one result exceeded the plant Eco-SSL of 220 mg/kg. Sixty-two results exceeded the invertebrate Eco-SSL. The maximum result from the subsurface depth interval of UM39 exceeded the avian and mammalian Eco-SSLs of 4,300 and 4,000 mg/kg, respectively. There currently is no background level established for manganese relevant for this evaluation. Manganese concentrations detected in the 75 samples are consistent with previous sampling events throughout RFS at areas not suspected of contamination. The ambient metals evaluation concluded that detected concentrations of manganese up to 5,900 mg/kg represent ambient concentrations and should not be considered for further evaluation (Tetra Tech 2015). Therefore, manganese does not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Mercury. Mercury was detected in 74 of 75 samples with concentrations ranging from 0.038 to 2.4 mg/kg. Twenty-eight samples exceeded the plant ORNL benchmark of 0.3 mg/kg. Confidence in the plant benchmark for inorganic mercury is low, as the toxicity threshold in a second study was more than two orders of magnitude higher (Efroymson 1997a). Fifty-four samples exceeded the invertebrate ORNL benchmark of 0.1 mg/kg. Confidence in the mercury invertebrate benchmark is also low, due to the limited amount of data (Efroymson 1997b). Back-calculated screening criteria for birds (30.5 mg/kg) and mammals (38.5 mg/kg) are available (see Table 5 for a description of the derivation methods). Risk decisions for mercury are based on comparison to the back-calculated values for birds and mammals, of which confidence levels are high; site concentrations are less than back-calculated values; therefore, mercury does not appear to pose risk to ecological receptors in the Upland Meadows. Mercury does not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Molybdenum. Molybdenum was detected in 74 of 75 samples with concentrations ranging from 0.16 to 3.1 mg/kg. One sampling result (UM41 from 0 to 0.5 feet bgs) exceeded the plant ORNL benchmark of 2 mg/kg. As noted above, elevated concentrations of molybdenum and other metals in this sample can be attributed to the presence of pyrite cinders, which were observed within the sample. There are no established benchmarks for invertebrates, birds, or mammals. Molybdenum does not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Nickel. Nickel was detected in all 75 samples with concentrations ranging from 20 to 280 mg/kg. Fifty-one results exceeded the plant Eco-SSL of 38 mg/kg. One result, from location UM19-FR1 (in one of three triplicate samples collected at this location and depth) exceeded the avian Eco-SSL of 210 mg/kg. Two results, the results of 170 from the subsurface depth interval at UM39 and 280 mg/kg from UM19, exceeded the mammalian Eco-SSL. There is no established benchmark for invertebrates. The ambient metals evaluation concluded that detected concentrations of nickel up to 280 mg/kg represent ambient concentrations and should not be considered for further evaluation (Tetra Tech 2015). Therefore, nickel does not appear to be an

indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Selenium. Selenium was detected in all 75 samples with concentrations ranging from 0.095 to 0.84 mg/kg. One sample result (UM41 from 0 to 0.5 feet bgs) exceeded the plant and mammal Eco-SSLs of 0.52 and 0.63 mg/kg, respectively. As noted above, elevated concentrations of metals in this sample can likely be attributed to the presence of pyrite cinders, which were observed within the sample. None of the results exceeded the invertebrate or avian Eco-SSLs of 4.1 and 1.2 mg/kg, respectively. Selenium does not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Vanadium. Vanadium was detected in all 75 samples with concentrations ranging from 32 to 70 mg/kg. All 75 results exceeded the plant ORNL benchmark and avian Eco-SSL of 2 and 7.8 mg/kg, respectively. None of the results exceeded the mammalian Eco-SSL of 280 mg/kg. There is no established benchmark for invertebrates. Vanadium does not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

Zinc. Zinc was detected in all 75 samples with concentrations ranging from 26 to 1,100 mg/kg. Four results, from the surface depth interval of UM41 (1,100 mg/kg) and UM42 (180 mg/kg), and from the subsurface depth intervals of UM39 (170 mg/kg) and UM25 (430 mg/kg), exceeded the plant Eco-SSL of 160 mg/kg. The same four samples plus the surface depth interval sample collected at UM34 (140 mg/kg) exceeded the invertebrate Eco-SSL of 120 mg/kg. Four results exceeded the avian Eco-SSL of 46 mg/kg, and 12 results exceed the mammalian Eco-SSL of 79 mg/kg. The elevated concentration of zinc at UM41 can be attributed to the presence of pyrite cinders, which were observed within the sample. Zinc does not appear to be an indicator of soil contamination and should not be considered a potential chemical of concern in the Upland Meadows.

4.1.2 PAHs

Soil samples were submitted for analysis of PAHs by EPA Method 8270-SIM (selective ion monitoring). Eighteen of the 20 target analytes were detected, predominantly in samples collected from 0 to 0.5 feet bgs; these results are presented in Table 8. None of the sample results exceeded the human health criteria for PAHs or the benzo(a)pyrene equivalency quotient. In addition, none of the results exceeded the plant ORNL benchmark for total low molecular weight PAHs, including 2-methylnapthalene, acenaphthylene, acenapthene, anthracene, fluorene, and phrenanthrene. There are no other ecological benchmarks available for PAHs.

4.1.3 PCBs

In the initial sampling event conducted in April 2015, all 75 samples were submitted for analysis of PCBs by EPA Method 8082. Aroclor-1248 was detected in four samples, Aroclor-1254 was detected in 46 samples, and Aroclor-1260 was detected in 43 samples. There were no detections of Aroclor-1016, Aroclor-1221, Aroclor-1232, or Aroclor-1242. Results are presented in Table 9.

The sample result from location UM33 collected from 0 to 0.5 feet bgs exceeded the TSCA screening criterion of 1 mg/kg total PCBs for high occupancy areas. This sample contained both Aroclor-1248 (2.2 mg/kg) and Aroclor-1254 (2.2 mg/kg) for a total of 4.4 mg/kg Aroclors.

In the supplementary PCB investigation in EPA Meadow North conducted in September 2015, all 18 samples were submitted for analysis of PCBs. Aroclor-1248 was detected in 15 samples, and Aroclor-1254 and -1260 were detected in all 18 samples. Similar to the initial sampling event results, there were no detections of Aroclor-1016, Aroclor-1221, Aroclor-1232, or Aroclor-1242. PCB results are presented in Table 9. The sample results from locations UM46, UM50, and UM51, which are all located within 25 feet of location UM33, collected from varying depths between 0 and 2.0 feet bgs, exceeded the TSCA screening criterion of 1 mg/kg total PCBs for high occupancy areas. These samples contained both Aroclor-1248 and Aroclor-1254 and ranged from 2.9 to 38 mg/kg total Aroclors. Figure 13 presents the PCB results from the initial and supplementary sampling investigations.

The plant Eco-SSL for Aroclor-1254 is 40 mg/kg. None of the detected results exceeded this benchmark. Eco-SSLs or ORNL benchmarks for PCBs have not been established for invertebrates, birds, and mammals, or for other PCB congeners for plants.

Further evaluation of PCBs in the immediate area around locations UM33, UM46, UM50, and UM51 is recommended and will be conducted as part of a separate future investigation.

4.1.4 VOCs

In total, 25 samples were collected from the 1.5 to 2 feet bgs depth interval; these were submitted for analysis of VOCs by EPA Method 8260. No VOCs were detected in any of the samples.

4.1.5 Pesticides

Eight samples were submitted for analysis of pesticides by EPA Method 8081A. Samples were collected from the surface interval at six locations, and a triplicate sample was collected at one of those locations. Pesticide results are presented in Table 10.

Nineteen of the 20 target analytes were detected (toxaphene was not detected), and none of the pesticides exceeded the maintenance worker or off-site receptor inhalation criteria. Results for 4,4'-DDD (0.035 mg/kg), 4,4'-DDE (0.029 mg/kg), and 4,4'-DDT (0.029 mg/kg) from location UM09 exceeded the mammalian Eco-SSL for all three pesticides (0.021 mg/kg). None of the other available ecological criteria were exceeded.

4.2 EXPLORATORY EXCAVATION RESULTS

The source of the magnetic anomaly was determined to be a large metal and cement-filled cylindrical building anchor, known as a "deadman" anchor. The anchor was approximately 6 feet long and was encountered at approximately 6 feet bgs in Trench 1. In addition, numerous sections of metal pipes and items such as metal posts set in concrete, as well as reinforced concrete and general metal debris, were also encountered in Trenches 1 and 2. The exploratory excavation activities and summary of findings are presented in the Final Completion Report, Exploratory Excavation for Magnetic Anomaly Source in Bulb, included as Attachment 8 to this memorandum. The completion report discusses mobilization and demobilization, site preparation and restoration, radiological and geophysical surveys, exploratory excavation and anomaly detection, backfilling, stockpiling, water management, and air monitoring.

No sources of radiological or chemical contamination (other than pyrite cinders) were visually observed or detected by the various hand-held meters, and therefore no soil samples were collected during the exploratory excavation activities. Water samples were collected from the on-site Baker tank used to store the groundwater that was pumped from the excavations and the water was determined to be non-hazardous based on analytical results (Attachment 8). Radiological monitoring results support that no radioactive contaminants were present within the study area at levels that would pose risk to human or ecological receptors, as discussed fully in the Completion Report (Attachment 8).

4.3 CARBON TETRACHLORIDE PASSIVE SOIL GAS SAMPLING RESULTS

Soil gas samples were collected at 32 locations, including triplicate samples collected at three locations, resulting in a total of 38 samples. The results represent the total measured contaminants present in the vapor phase within soil pore spaces at each location. The results were intended to be used to indicate if a source area for carbon tetrachloride exists within soil at the study area or to determine if a groundwater contaminant plume can be identified within the study area.

The AGI Universal passive soil gas samplers were submitted for analysis of VOCs by EPA Method 8260; results are reported as a mass concentration in micrograms (µg) detected within each AGI sampler. Of the 38 samples, benzene was detected in 14 samples, m-p-xylene was detected in four samples, benzene, toluene, ethylbenzene, and xylene (BTEX) was detected in 16 samples, octane was detected in two samples, toluene was detected in 11 samples, and total petroleum hydrocarbons (TPH) were detected in 11 samples. Table 11 presents the results of the passive soil gas samples. Complete analytical results are presented in Appendix B and the laboratory report is included in Attachment 2.

Carbon tetrachloride was detected in five samples at four locations: SGCT2, SGCT7 (in two of three triplicate samples collected at this location), SCGT17, and SCGT32. Detected concentrations ranged from 0.02 to 0.05 µg; the detection limit for carbon tetrachloride is 0.02 µg. The low sample concentrations and distribution do not indicate a soil source area or groundwater plume within the study area. The detections of carbon tetrachloride are presented on Figure 7.

BTEX (and its compounds) and TPH were detected at 16 locations throughout the study area. Detected concentrations of BTEX ranged from 0.02 to 0.11 µg with a detection limit of 0.02 µg. Detected concentrations of TPH ranged from 0.56 to 2.17 µg with a detection limit of 0.5 µg. The low concentrations and random distribution do not indicate a soil source area or groundwater plume within the study area. The detections of BTEX and TPH are presented on Figure 8.

Results of the soil gas survey do not indicate the presence of a soil or groundwater source for carbon tetrachloride in the study area. There are no published or industry-standard screening criteria for passive soil gas results; however, the detections at the laboratory reporting limits for the samples do not support the presence of elevated contaminants; soil or groundwater. The distribution of carbon tetrachloride, BTEX, and TPH do not indicate any pattern from which the presence of a source, or the direction of a source, can be determined. Carbon tetrachloride or petroleum-related contaminants could have been introduced to the subsurface through small spills in the general area; however, there is no specific documentation or history of spills, and the low concentrations of detected chemicals do not suggest a measurable or definable source area.

4.4 BAPB AREA GROUNDWATER SAMPLING RESULTS

Groundwater samples collected from the four piezometers installed around the BAPB area were submitted for analysis of metals and VOCs. In addition, a field duplicate was collected at piezometer WSM01. These results are presented in Tables 12 and 13. Complete analytical results are presented in Appendix C and the laboratory report is presented in Attachment 3.

Screening criteria for groundwater samples are aquatic screening criteria for ambient water quality criteria and marine aquatic toxicity criteria. The screening criteria are consistent with criteria applied during previous investigations to evaluate the BAPB-area groundwater in the same area (Terraphase 2012, 2014). The notes in Tables 12 and 13 present the derivation of the screening criteria.

4.4.1 Metals

Five samples from four locations (one from each piezometer and one duplicate from ETA02) were submitted for analysis of metals by EPA Methods 6020A and 7471A. All metals except total chromium, copper, lead, and silver were detected. There are aquatic water quality criteria for a subset of metals, including antimony, arsenic, cadmium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. Detected results were compared with aquatic screening criteria in Table 12.

A review of sample results for the BAPB area piezometers installed by Zeneca's consultants between 2011 and 2014 indicates that concentrations of nickel, selenium, and zinc exceed the corresponding aquatic screening criterion (Terraphase 2012, 2014, 2015). Of these three metals, nickel and zinc were detected at concentrations exceeding the aquatic screening criteria in at least one sample from the newly-installed Phase IV piezometers. Results from the Phase IV piezometers for these metals and mercury are presented and discussed below.

Nickel. Nickel was detected in three samples (two original samples and a duplicate), with concentrations of 27 micrograms per liter (µg/L) at ETA02 (both in the original and duplicate sample) and 140 µg/L at ETA03. The maximum concentration exceeded the aquatic screening criterion of 41 µg/L (based on five times the marine aquatic toxicity criterion of 8.2 µg/L). Figure 9 presents nickel concentrations in piezometers in the vicinity of the BAPB wall, as well as upgradient and crossgradient results.

Zinc. Zinc was detected in all five samples with concentrations ranging from 15 to 1,200 µg/L. The maximum concentration from location ETA03 exceeded the aquatic screening criteria of 410 µg/L (based on five times the marine aquatic toxicity criterion of 81 µg/L). Figure 10 presents zinc concentrations in piezometers in the vicinity of the BAPB wall, as well as upgradient and crossgradient results.

Mercury. Mercury is a chemical of concern associated with the production of mercury fulminate, used to manufacture blasting caps in the area directly upgradient of ETA01; ETA01 was installed crossgradient of the BAPB wall. Mercury was reported at 4.7 µg/L in piezometer ETA01. This result is less than the aquatic screening criterion of 11 µg/L (based on five times the marine aquatic toxicity criterion of 2.1 µg/L), but higher than results previously reported in nearby piezometers MFA and ETA, and in piezometers in the immediate vicinity of the BAPB. Mercury was not detected in the other Phase IV piezometers, located upgradient of the BAPB, suggesting there is no mercury contamination in groundwater upgradient of the BAPB originating from

former California Cap Company operations. Figure 11 presents mercury concentrations in piezometers in the vicinity of the BAPB wall, as well as upgradient and crossgradient results.

4.4.2 VOCs

Five samples from four locations were submitted for analysis of VOCs by EPA Method 8260. Of the 71 VOCs, 15 were detected: 1,1,2-trichloroethane, 1,1-dichloroethylene, 2-butanone, acetone, benzene, chlorobenzene, chloroform, cis-1,2-dichloroethylene, methyl tert-butyl ether (MTBE), tert-Butyl alcohol, tetrachloroethylene, trans-1,2-dichloroethylene, trichloroethylene, and vinyl chloride. Detected results are compared with aquatic screening criteria in Table 13. None of the Phase IV piezometers upgradient or crossgradient of the BAPB had results exceeding the aquatic screening criterion.

5.0 SUMMARY

An evaluation of Phase IV soil, soil gas, and groundwater data indicate that all DQOs were achieved, and no significant deviations from the Phase IV FSP occurred. The evaluation did not identify immediate or potential threats to human health or the environment; however, some concentrations of chemicals of concern exceeded relevant screening criteria at some locations.

5.1 UPLAND MEADOWS SOIL SAMPLING RESULTS SUMMARY

The results of the soil sampling investigation in the Upland Meadows indicate that (1) pyrite cinders are present in the around the City of Richmond sanitary main near location UM41, resulting in elevated concentrations of metals; and (2) PCBs are present at concentrations exceeding the TSCA criterion of 1 mg/kg in the northeast corner of the EPA Meadow North. Pyrite cinders are managed under the Soil Management Plan at RFS as described in Section 5.2.3 of the RAW (Tetra Tech 2014b) and no further investigation is recommended. Based on the sample results collected during both sampling events at the EPA Meadow North, further evaluation of PCBs is recommended.

All other sampling results indicate that detected chemicals are present at ambient conditions or background conditions, and no further sampling is recommended. Detected concentrations do not pose unacceptable risk to human or ecological receptors warranting additional sampling, removal actions, or full-scale risk assessments.

5.2 EXPLORATORY EXCAVATION RESULTS SUMMARY

The findings of the exploratory excavation of the magnetic anomaly in the Bulb indicate that drums are not present in the Bulb subsurface in the study area, and rather that construction debris was the source of the magnetic anomaly. No further investigation of the magnetic anomaly is recommended. Additional investigation within the ETA (including the Bulb) will be recommended in the Phase V FSP.

5.3 CARBON TETRACHLORIDE PASSIVE SOIL GAS SAMPLING RESULTS SUMMARY

The results of the soil gas investigation in the carbon tetrachloride area do not indicate a soil contaminant source, or provide additional information regarding potential groundwater concentrations surrounding piezometer CPT. UC Berkeley will continue with implementation of the groundwater remedy presented in the RAW for the carbon tetrachloride area (Tetra Tech 2014b).

5.4 BAPB AREA GROUNDWATER SAMPLING RESULTS SUMMARY

BAPB area groundwater results indicate that concentrations of nickel and zinc exceed the aquatic screening criteria in the newly installed BAPB piezometers. These piezometers are recommended for inclusion into the annual groundwater monitoring program.

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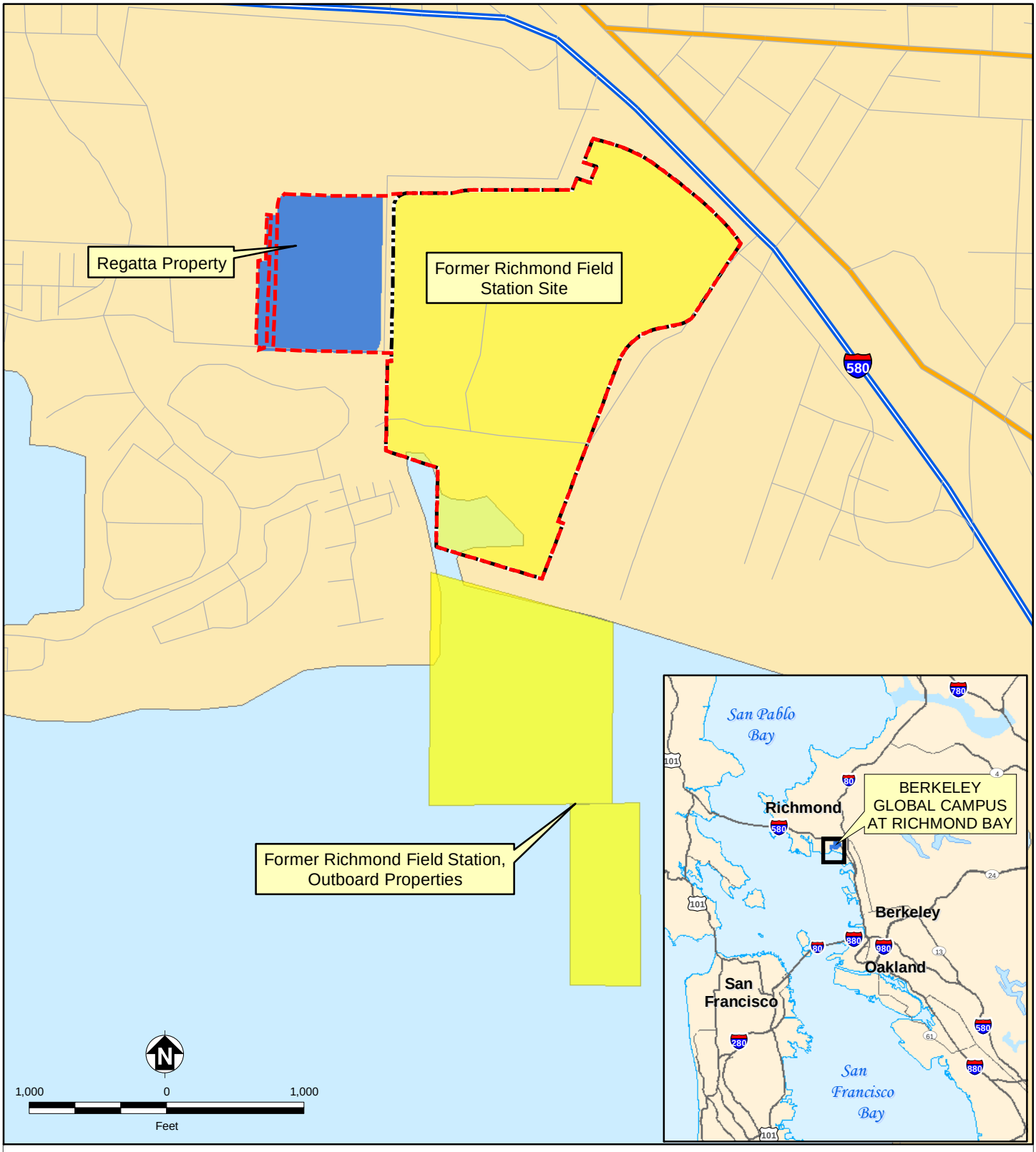
FIGURES



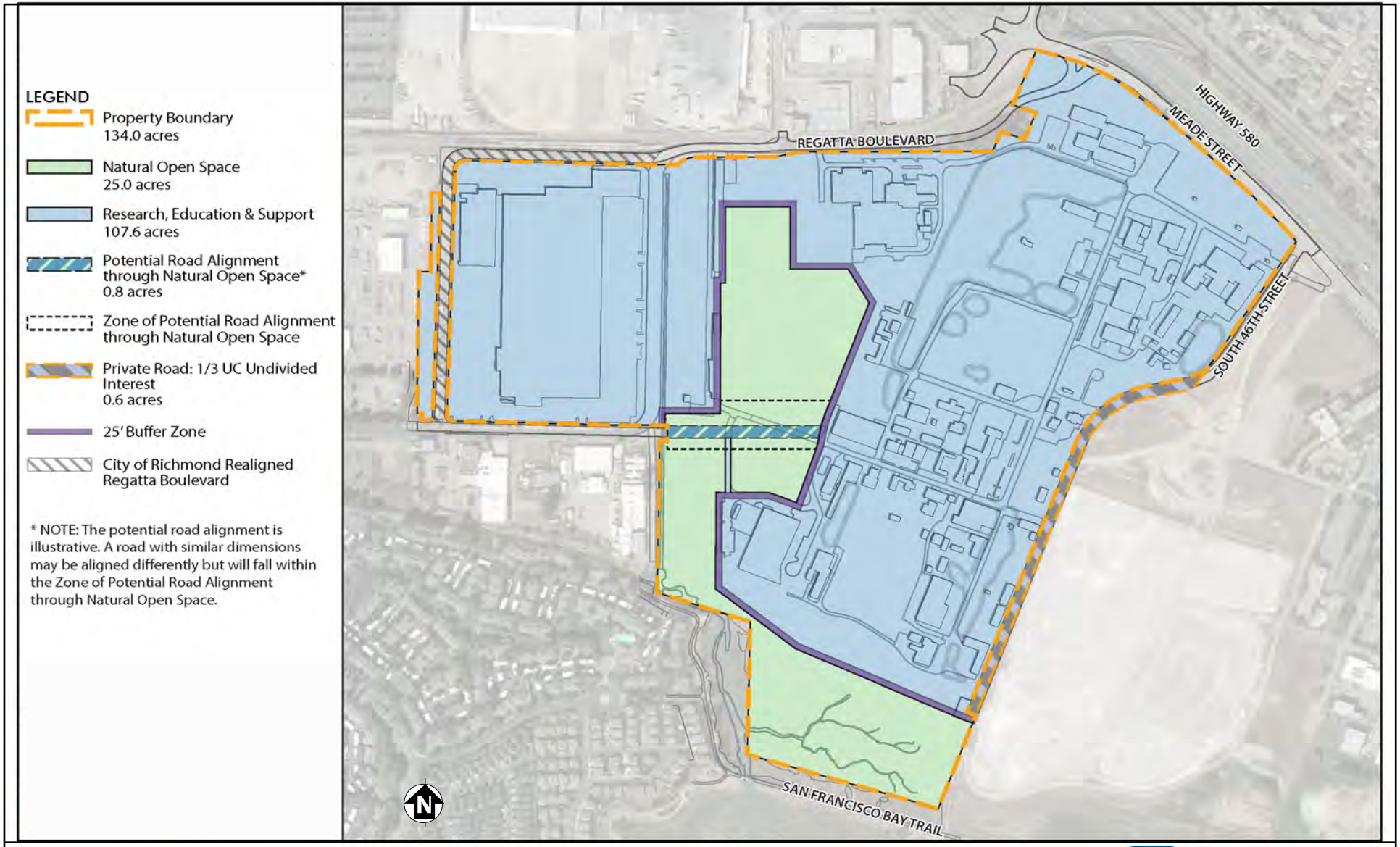
TETRA TECH

- Berkeley Global Campus Boundary at Richmond Bay
- Former Richmond Field Station Site Boundary
- Regatta Property
- Former Richmond Field Station Properties

Richmond Field Station Site
University of California, Berkeley

FIGURE 1
SITE LOCATION MAP

Phase IV Sampling Results Technical Memorandum



Source:
University of California. 2014.
Figure 4.1, Land Use Plan. Richmond Bay Campus Long Range Development Plan. May 15.

TETRA TECH

Richmond Field Station Site
University of California, Berkeley

FIGURE 2
BERKELEY GLOBAL CAMPUS AT RICHMOND BAY
LAND USES

Phase IV Sampling Results Technical Memorandum

Carbon Tetrachloride Soil Gas Sampling

Upland Meadows Soil Sampling

Big Meadow

West Meadow

EPA Meadow North

Upland Area

Bulb

Bulb Investigation

BAPB Area Piezometers

Western Stege Marsh

Campus Bay Site (Former Zeneca Site)

201 EPA Lab

GEOSCIENCES WELL FIELD

REGATTA BOULEVARD

SOUTH 34TH STREET

MEAKER AVENUE

ERLANDSON STREET

HIGHWAY 580

MEADE STREET

ROBIN DRIVE

OWL WAY

WREN DRIVE

EGRET WAY

JAY WAY

PLOVER DRIVE

CROW DRIVE

LARK DRIVE

HERON DRIVE

AVOCET WAY

STARLING WAY

FLUME

SOUTH 32ND STREET

SOUTH 36TH ST

EAST MONTGOMERY AVENUE

ROCKPORT COURT

CRYSTAL COVE COURT

Meeker Slough

280B 280A 400 454 453 452 451 490 450 460 480 482 486 445 484 488 485 487 421 474 473 420 471 472 470 475 300 167 1901 165 164 38 162 161 190 194 196 277 160 159 158 154 151 180 179 155 177 195 275 276 153 152 198 150 476 175 149 197 121 118 125 116 117 120 114 111 113 128 112 178 185 110 102 163

0 100 200 400

Feet

Bulb Investigation
Upland Meadows Area Soil Sampling Location
Carbon Tetrachloride Soil Gas Sampling Location
BAPB Wells on RFS Property
Western Stege Marsh
Transition Area
Designated Natural Open Space
Meadow Boundary
Carbon Tetrachloride Investigation Area

BAPB Area Piezometer Location
Existing Piezometer
Former Richmond Field Station Site Boundary

Sanitary Sewer Lines:
Existing Sewer Line
Removed Sewer Line
Abandoned Sewer Line

Storm Drain Lines:
Open Swale
Underground Culvert
Underground Culvert, Abandoned (Grouted at Manholes)

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Richmond Field Station Site
University of California, Berkeley

FIGURE 3
PHASE IV SAMPLING AREAS

Phase IV Sampling Results Technical Memorandum

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Former Richmond Field Station Site Boundary
Upland
Transition Area
Eastern Transition Area (Remediated)
Western Transition Area
Remediated portion of Western Stege Marsh
Meadow Boundary

Notes:
Meadow extents shown are the portion of the meadows within the designated Natural Open Space.

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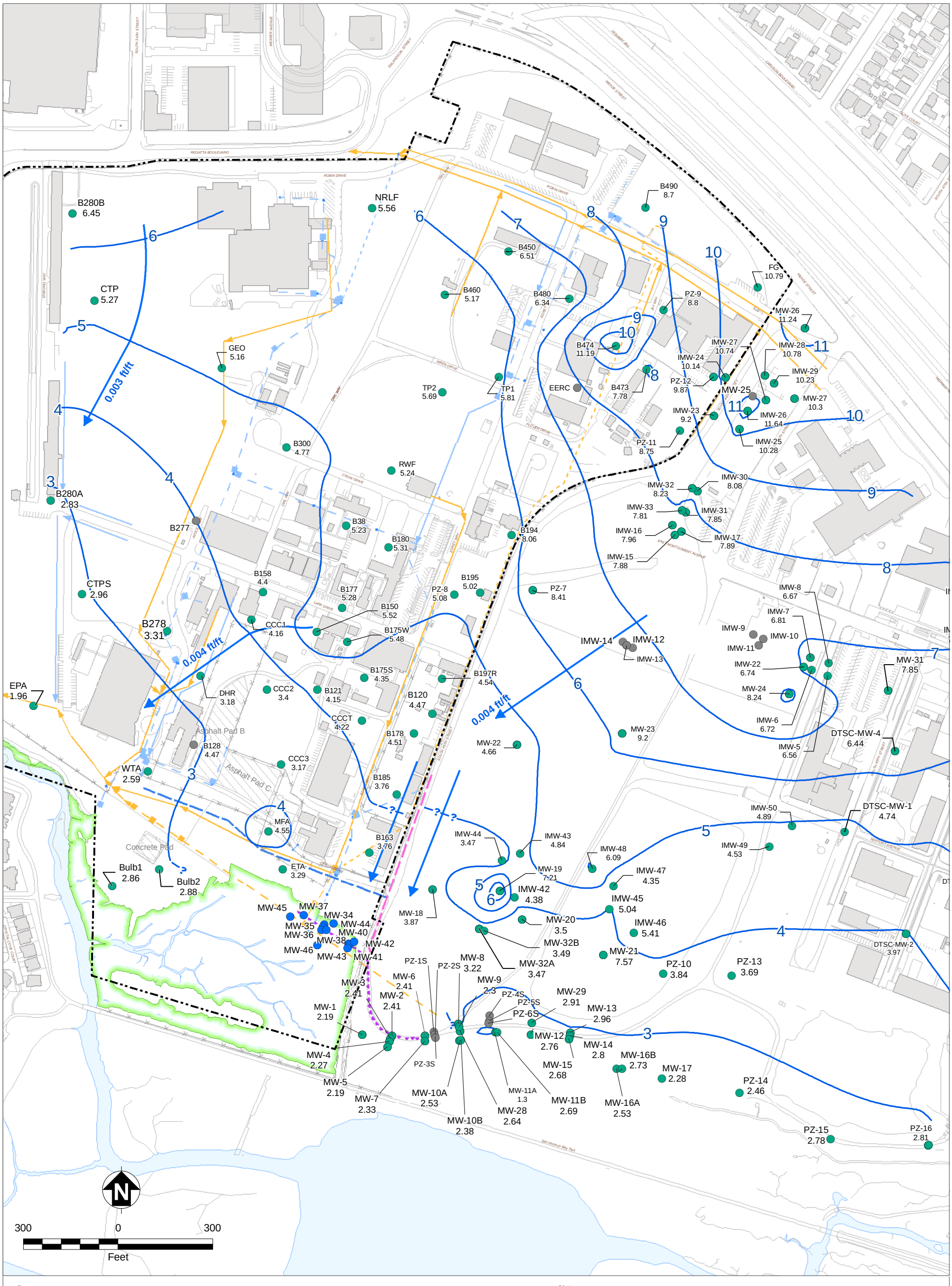
Richmond Field Station Site
University of California, Berkeley

FIGURE 4
SITE MAP

Phase IV Sampling Results Technical Memorandum

6/8/2015 V:\Misc_GIS\Richmond_Field_Station\Projects\Field_Sampling_Workplan\Phase_IV\layouts\SITE MAP.mxd - colin.lee



- Piezometer Groundwater Elevation Measured in October 2014
- Piezometer Groundwater Elevation Not Measured in October 2014
- BAPB Wells on RFS Property
- Estimated October 2014 Groundwater Contour
- Contour Estimated due to Proximity to BAPB Wall, Slurry Wall, or Marsh
- Estimated Horizontal Groundwater Gradient Direction (Value)
- Existing Building
- Asphalt/Concrete Pad
- Surface Water
- Marsh Boundary
- Richmond Field Station Site Boundary
- Roads and Other Landscape Features
- Fenceline
- BAPB Wall
- Former Seawall (Approximate)
- Slurry Wall

Storm Drain Lines:

- Open Swale
- Underground Culvert
- Underground Culvert, Abandoned (Grouted at Manholes)

Sanitary Sewer Lines:

- Existing Sewer Line
- Removed Sewer Line
- Abandoned Sewer Line

MW-10A 5.27 — Piezometer ID; Groundwater Elevation (FT NGVD29)

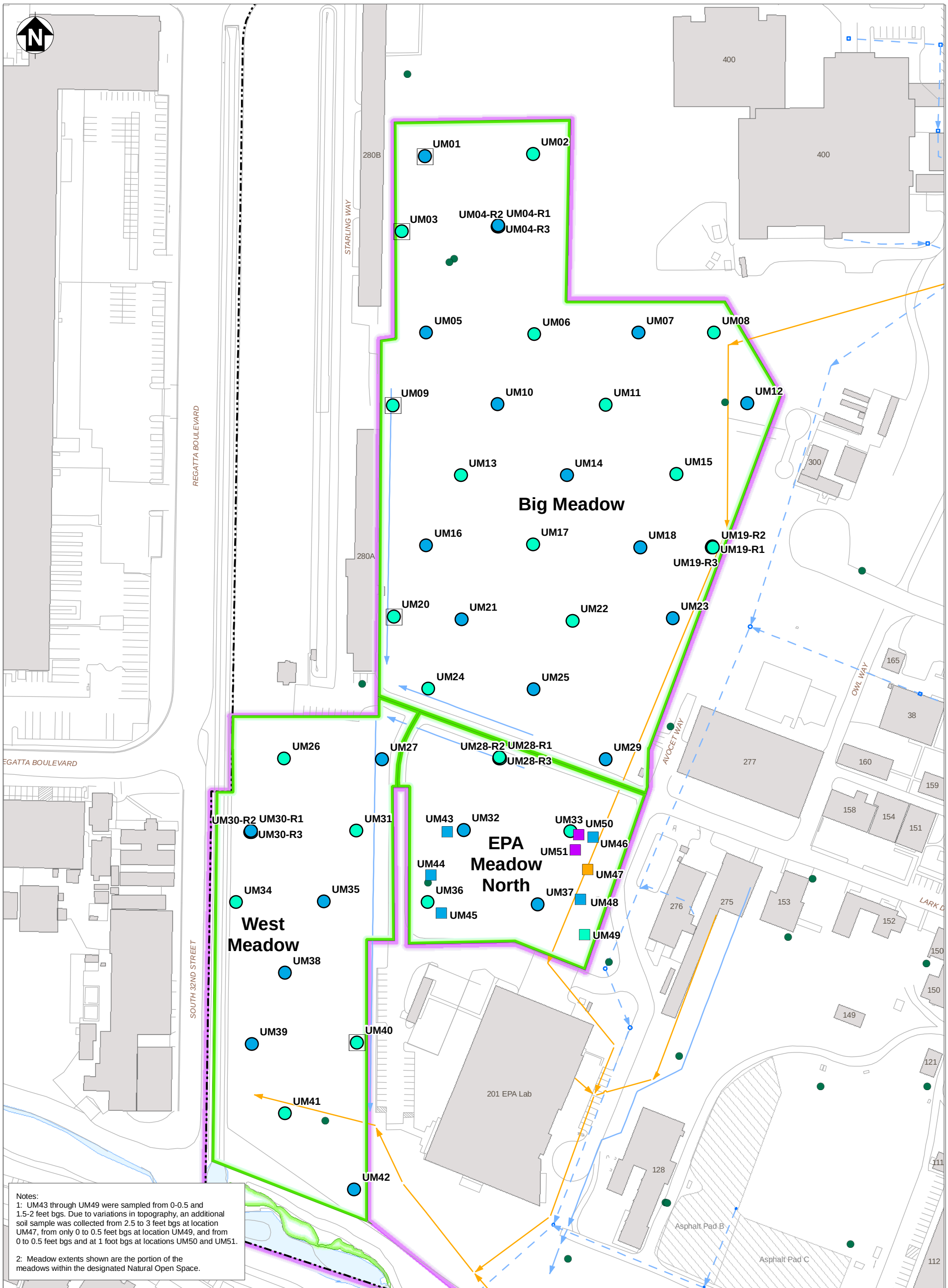
Note:
All data points surveyed to NGVD29.
Mean sea level = NGVD29 elevation (in feet) – 0.58 feet NGVD and mean sea level datum representative of Stege Marsh is derived from NOAA Richmond Inner Harbor tide gauge.
Contours do not include data from Phase IV piezometers completed in January 2015.

TETRA TECH

Richmond Field Station Site
University of California, Berkeley

FIGURE 5
SHALLOW GROUNDWATER ELEVATION CONTOURS, OCTOBER 1, 2014

Phase IV Sampling Results Technical Memorandum



Notes:
1: UM43 through UM49 were sampled from 0-0.5 and 1.5-2 feet bgs. Due to variations in topography, an additional soil sample was collected from 2.5 to 3 feet bgs at location UM47, from only 0 to 0.5 feet bgs at location UM49, and from 0 to 0.5 feet bgs and at 1 foot bgs at locations UM50 and UM51.

2: Meadow extents shown are the portion of the meadows within the designated Natural Open Space.

Soil Sampling Locations
- 0-0.5 feet bgs Soil Sampling Location
- 0-0.5 and 1.5-2 feet bgs Soil Sampling Location

Supplemental PCB Soil Sampling Location[1]
- 0 to 0.5 feet bgs Supplemental Soil Sampling Location
- 0-0.5 and 1.5-2 feet bgs Supplemental Soil Sampling Location
- 1 foot bgs Supplemental Soil Sampling Location
- 2.5 to 3 feet bgs Supplemental Soil Sampling Location
- Sample Location Included Pesticide Analysis
- Designated Natural Open Space

- Meadow Boundary[2]
- Existing Buildings
- Asphalt/Concrete Pads
- Former Richmond Field Station Site Boundary
- Roads and Other Landscape Features
- Piezometer Location

Storm Drain Lines:
- Open Swale
- Underground Culvert
- Underground Culvert, Abandoned (Grouted at Manholes)

Sanitary Sewer Lines:
- Existing Sewer Line
- Removed Sewer Line
- Abandoned Sewer Line

125 0 125
Feet

TETRA TECH

Richmond Field Station Site
University of California, Berkeley

FIGURE 6
UPLAND MEADOWS SAMPLING LOCATIONS

Phase IV Sampling Results Technical Memorandum

B280B

CTP-06

CTP-05

CTP-04

400

280B

SGCT2
0.03

SGCT1

SGCT3

SGCT4

CTP-10

CTP-09

SGCT7-R2
0.03

CTP-16

SGCT5

CTP-08

SGCT6

SGCT7-R1
0.05

SGCT7-R3

SGCT8

SGCT9

CTP-11

SGCT10

SGCT11

SGCTG12

SGCT13

CTP-15

CTP-17

SGCT16

CTP-12

SGCT14

SGCT15

SGCT17
0.02

SGCT18

SGCT19

CTPDEEP

CTP

SGCT22-R2

CTP-14

SGCT20

SGCT21

SGCT23

SGCT22-R1

SGCT22-R3

CTP-13

SGCT26

SGCT27-R1

SGCT28

SGCT24

SGCT25

SGCT27-R2

SGCT27-R3

STARLING WAY

Estimated
Direction of
Groundwater Flow

SGCT29

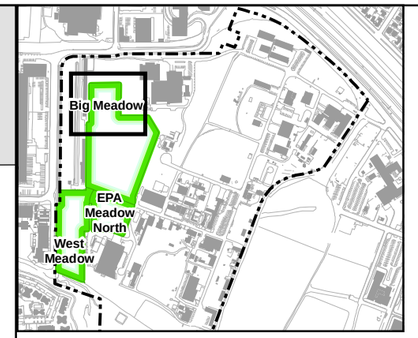
SGCT30

SGCT31

SGCT32
0.03

CTP-19

CTP-20



Passive Soil Gas Sampling Location

- Soil Gas Sampling Location (Carbon Tetrachloride Non-Detect)
- Location where Carbon Tetrachloride was Detected

Soil Gas Sampling Location ID

SGCT2
0.02

Carbon tetrachloride result (micrograms)[3]

Phase I FSW Piezometer Groundwater[1]

- < 2.63 µg/L (Commercial Vapor Intrusion RBC for Carbon tetrachloride)
- ≥ 2.63 µg/L (Commercial Vapor Intrusion RBC for Carbon tetrachloride)

Phase III FSW Grab Groundwater[2]

- Non-detect
- Carbon tetrachloride Detected
- Existing Building
- Roads and Other Landscape Features

Notes:

1 The maximum concentration at each location is represented.

2 Grab groundwater samples are not considered to be high quality data, therefore the concentrations detected were not compared to screening criteria. The target of the investigation was to confirm or deny the existence of an upgradient source of carbon tetrachloride, therefore this figure indicates whether carbon tetrachloride was detected at each location.

3 Detection limit is 0.02 micrograms.

N

0 25 50 100

Feet

TETRA TECH

Richmond Field Station Site
University of California, Berkeley

FIGURE 7
CARBON TETRACHLORIDE PASSIVE SOIL GAS SAMPLING LOCATIONS AND DETECTED RESULTS

Phase IV Sampling Results Technical Memorandum

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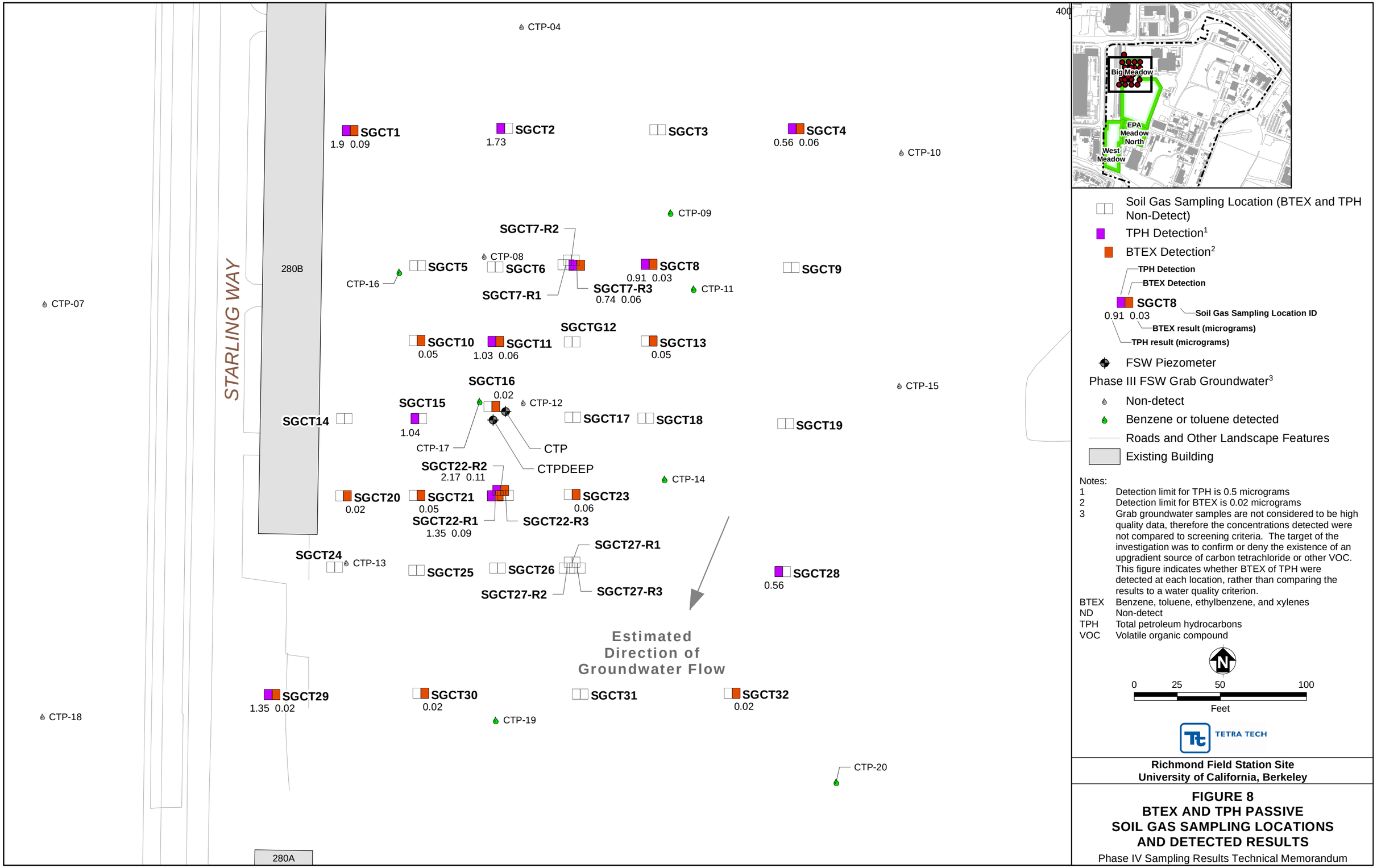


Notes:

1 Detection limit for TPH is 0.5 micrograms

2 Detection limit for BTEX is 0.02 micrograms

3 Grab groundwater samples are not considered to be high quality data, therefore the concentrations detected were not compared to screening criteria. The target of the investigation was to confirm or deny the existence of an upgradient source of carbon tetrachloride or other VOC. This figure indicates whether BTEX of TPH were detected at each location, rather than comparing the results to a water quality criterion.

BTEX Benzene, toluene, ethylbenzene, and xylenes

ND Non-detect

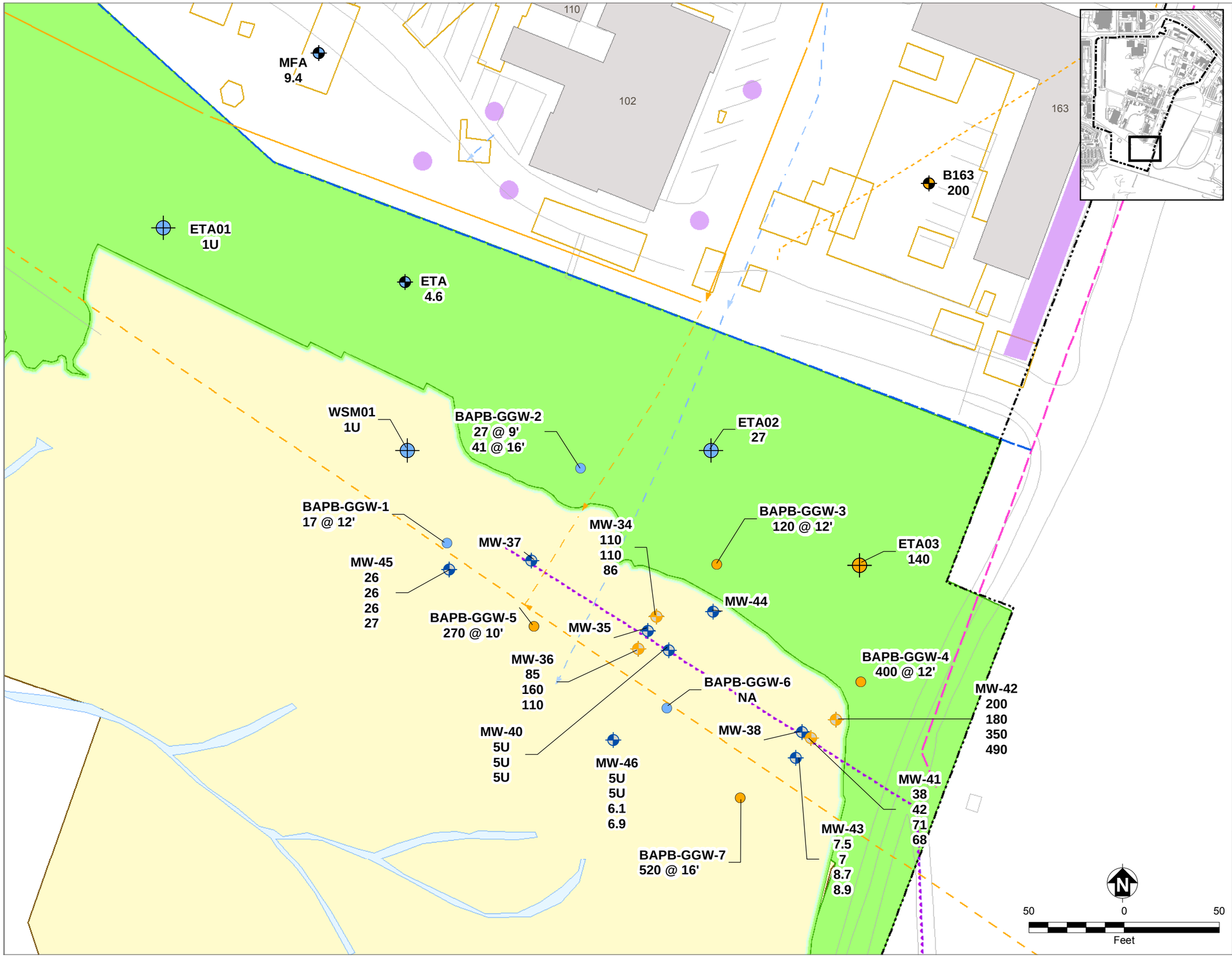
TPH Total petroleum hydrocarbons

VOC Volatile organic compound

Richmond Field Station Site
University of California, Berkeley

FIGURE 8
BTEX AND TPH PASSIVE SOIL GAS SAMPLING LOCATIONS AND DETECTED RESULTS

Phase IV Sampling Results Technical Memorandum



UC BAPB Piezometer[1] - Installed in 2015

- Nickel ≤ 41 µg/L[2]
- Nickel > 41 µg/L[2]

FSW Piezometer[1]

- Nickel ≤ 41 µg/L[2]
- Nickel > 41 µg/L[2]

Zeneca Piezometer/Well[1]

- Nickel ≤ 41 µg/L[2]
- Nickel > 41 µg/L[2]

Zeneca Grab Groundwater Sampling Location[3]

- Nickel ≤ 41 µg/L[2]
- Nickel > 41 µg/L[2]
- BAPB Wall

Sanitary Sewer Lines:

- Existing Sewer Line
- Removed Sewer Line
- Abandoned Sewer Line

Storm Drain Line:

- Open Swale
- Underground Culvert
- Underground Culvert, Abandoned
- Former Seawall (Approximate)
- Slurry Wall (Installed in 2002)
- Former Richmond Field Station Site Boundary
- Roads and Other Landscape Features
- Marsh Boundary
- Existing Buildings
- Former California Cap Company Buildings (Approximate)
- Known Pyrite Cinders Area
- Surface Water
- Eastern Transition Area (Remediated)
- Remediated portion of Western Stege Marsh

NOTES:
1. Results listed are for 2014 and 2015. If no results are listed, the piezometer was not sampled during this time period.

2. Aquatic screening criterion, based on 5 times the marine aquatic toxicity criterion.

3. Grab groundwater samples were collected in May 2012. Sampling depths are presented in feet bgs following the result. Only results for samples collected in the shallow depth interval (less than 20 feet bgs) were listed.

--	Not sampled
BAPB	Biologically Active Permeable Barrier
bgs	Below ground surface
µg/L	Micrograms per liter
J	Estimated
NA	No result available within shallow depth interval
U	Not detected

TETRA TECH

Richmond Field Station Site
University of California, Berkeley

FIGURE 9
NICKEL GROUNDWATER CONCENTRATIONS IN AND UPGRADIENT OF THE BAPB AREA
Phase IV Sampling Results Technical Memorandum

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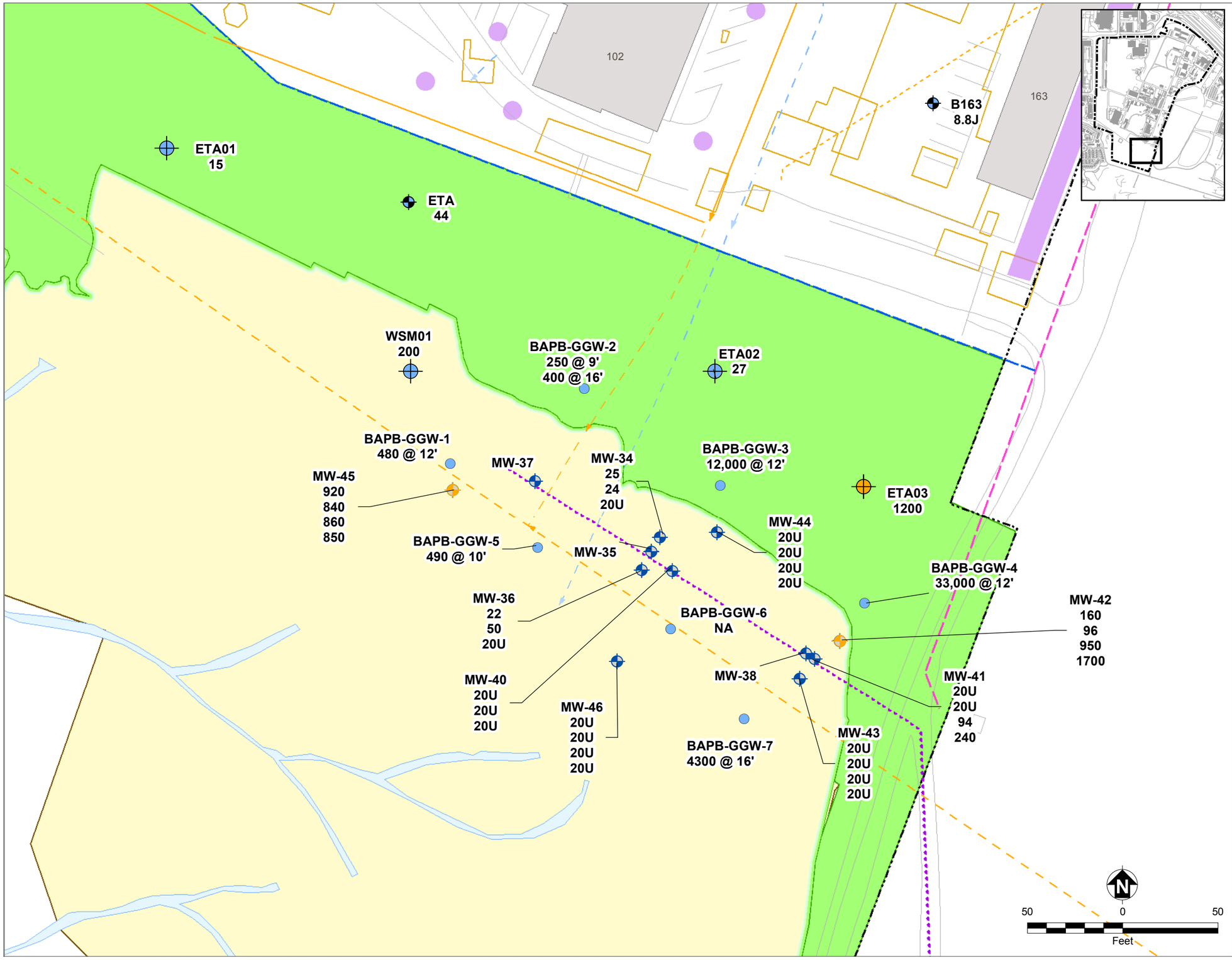

UC BAPB Piezometer[1] - Installed in 2015

- Zinc ≤ 410 µg/L[2]
- Zinc > 410 µg/L[2]
- **FSW Piezometer, Zinc ≤ 410 µg/L[2]**

Zeneca Piezometer/Well[1]

- Zinc ≤ 410 µg/L[2]
- Zinc > 410 µg/L[2]
- **Zeneca Grab Groundwater Sampling Location [3], Zinc ≤ 410 µg/L[2]**
- BAPB Wall

Sanitary Sewer Lines:

- Existing Sewer Line
- Removed Sewer Line
- Abandoned Sewer Line

Storm Drain Line:

- Open Swale
- Underground Culvert
- Underground Culvert, Abandoned
- Former Seawall (Approximate)
- Slurry Wall (Installed in 2002)
- Former Richmond Field Station Site Boundary
- Roads and Other Landscape Features
- Marsh Boundary
- Existing Buildings
- Former California Cap Company Buildings (Approximate)
- Known Pyrite Cinders Area
- Surface Water
- Eastern Transition Area (Remediated)
- Remediated portion of Western Stege Marsh

NOTES:
1. Results listed are for 2014 and 2015. If no results are listed, the piezometer was not sampled during this time period.

2. Aquatic screening criterion, based on 5 times the marine aquatic toxicity criterion

3. Grab groundwater samples were collected in May 2012. Sampling depths are presented in feet bgs following the result. Only results for samples collected in the shallow depth interval (less than 20 feet bgs) were listed.

--	Not sampled
BAPB	Biologically Active Permeable Barrier
bgs	Below ground surface
µg/L	Micrograms per liter
J	Estimated
NA	No result available within shallow depth interval
U	Not detected

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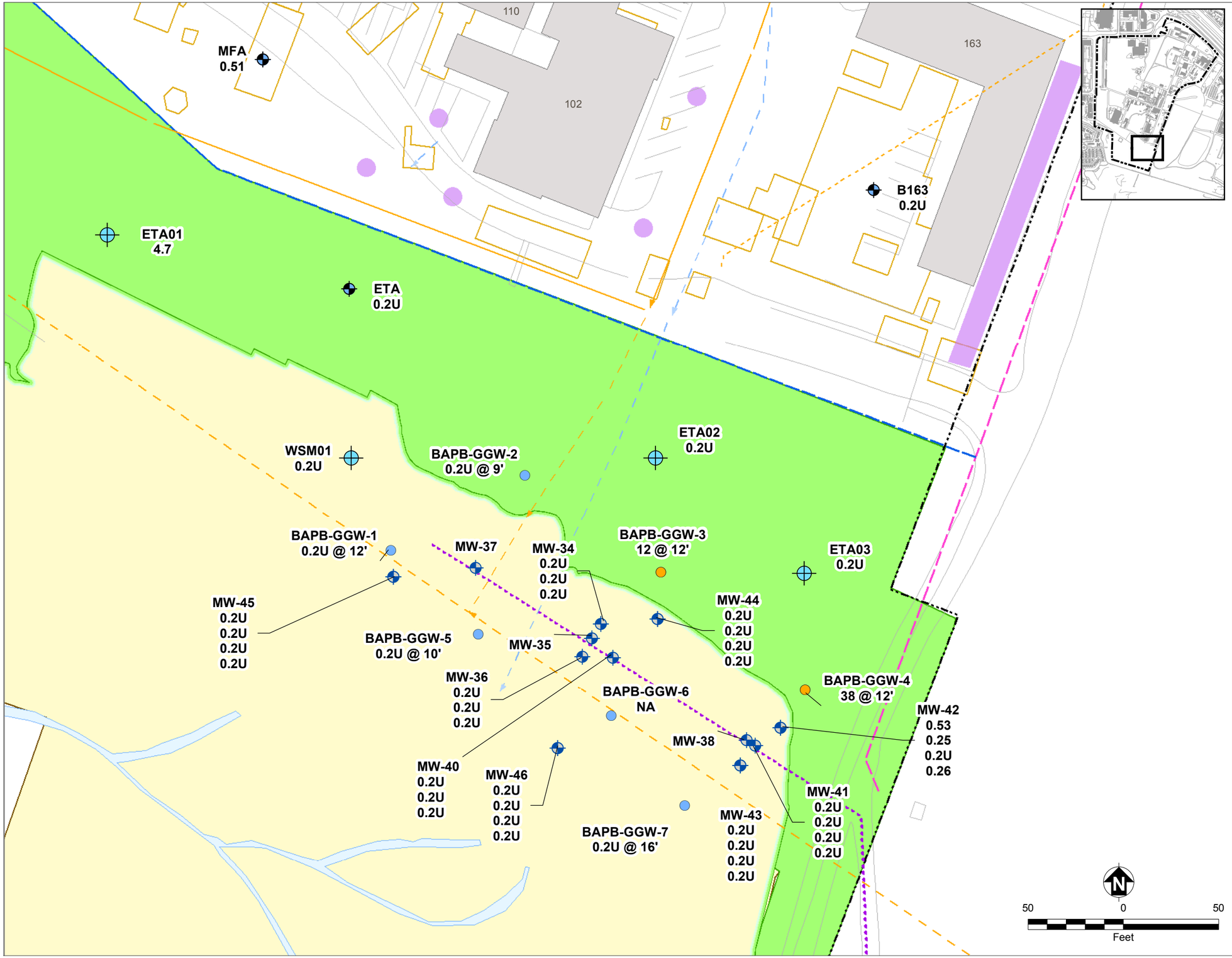
FIGURE 10
ZINC GROUNDWATER CONCENTRATIONS IN AND UPGRADIENT OF THE BAPB AREA

Phase IV Sampling Results Technical Memorandum



UC BAPB Piezometer[1] – Installed in 2015, Mercury ≤ 11 µg/L[2]

FSW Piezometer, Mercury ≤ 11 µg/L[2]

Zeneca Piezometer/Well, Mercury ≤ 11 µg/L[2]

Zeneca Grab Groundwater Sampling Location[3]

- Mercury ≤ 11 µg/L[2]
- Mercury > 11 µg/L[2]

Sanitary Sewer Lines:

- Existing Sewer Line
- Removed Sewer Line
- Abandoned Sewer Line

Storm Drain Line:

- Open Swale
- Underground Culvert
- Underground Culvert, Abandoned
- BAPB Wall
- Former Seawall (Approximate)
- Slurry Wall (Installed in 2002)
- Former Richmond Field Station Site Boundary
- Roads and Other Landscape Features
- Marsh Boundary
- Existing Buildings
- Former California Cap Company Buildings (Approximate)
- Known Pyrite Cinders Area
- Surface Water
- Eastern Transition Area (Remediated)
- Remediated portion of Western Stege Marsh

NOTES:
1. Results listed are for 2014 and 2015. If no results are listed, the piezometer was not sampled during this time period.

2. Aquatic screening criterion, based on 5 times the marine aquatic toxicity criterion.

3. Grab groundwater samples were collected in May 2012. Sampling depths are presented in feet bgs following the result. Only results for samples collected in the shallow depth interval (less than 20 feet bgs) were listed.

--	Not sampled
BAPB	Biologically Active Permeable Barrier
bgs	Below ground surface
µg/L	Micrograms per liter
J	Estimated
NA	No result available within shallow depth interval
U	Not detected

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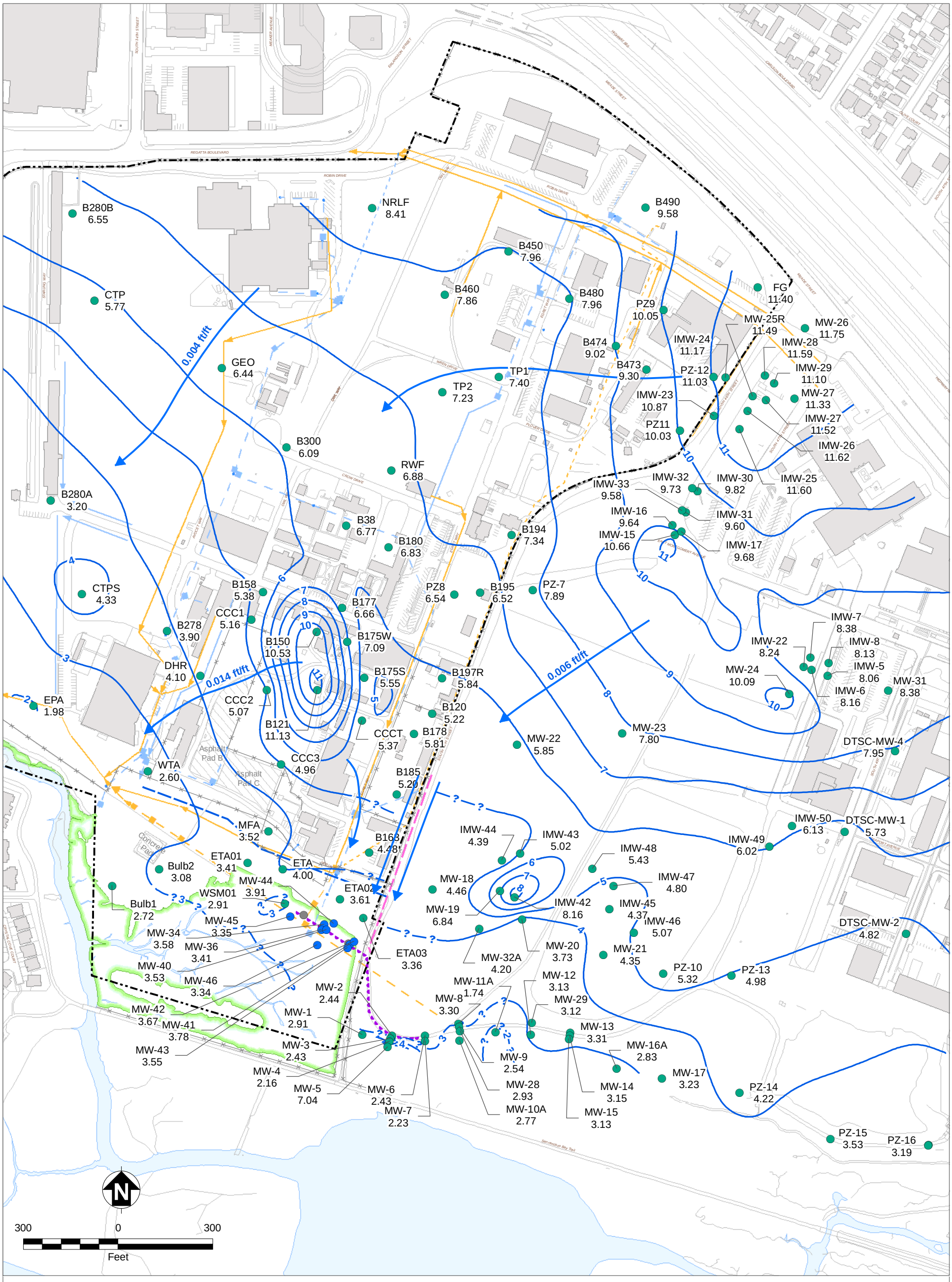
FIGURE 11
MERCURY GROUNDWATER CONCENTRATIONS IN AND UPGRADIENT OF THE BAPB AREA

Phase IV Sampling Results Technical Memorandum



- Piezometer Groundwater Elevation Measured in April 2015
- BAPB Wells on RFS Property
- BAPB Wells on RFS Property Not Measured in April 2015
- 1 Estimated April 2015 Groundwater Contour
- ? Contour Estimated due to Proximity to BAPB Wall, Slurry Wall, or Marsh
- Estimated Horizontal Groundwater Gradient Direction (Value)
- Existing Building
- Asphalt/Concrete Pad
- Surface Water
- Marsh Boundary
- Richmond Field Station Site Boundary
- Roads and Other Landscape Features
- Fenceline

- BAPB Wall
- Former Seawall (Approximate)
- Slurry Wall

Storm Drain Lines:

- Open Swale
- Underground Culvert
- Underground Culvert, Abandoned (Grouted at Manholes)

Sanitary Sewer Lines:

- Existing Sewer Line
- Removed Sewer Line
- Abandoned Sewer Line

MW-10A 5.27 — Piezometer ID; Groundwater Elevation (FT NGVD29)

Note:
All data points surveyed to NGVD29.
Mean sea level = NGVD29 elevation (in feet) – 0.58 feet and mean sea level datum representative of Stege Marsh is derived from NOAA Richmond Inner Harbor tide gauge.

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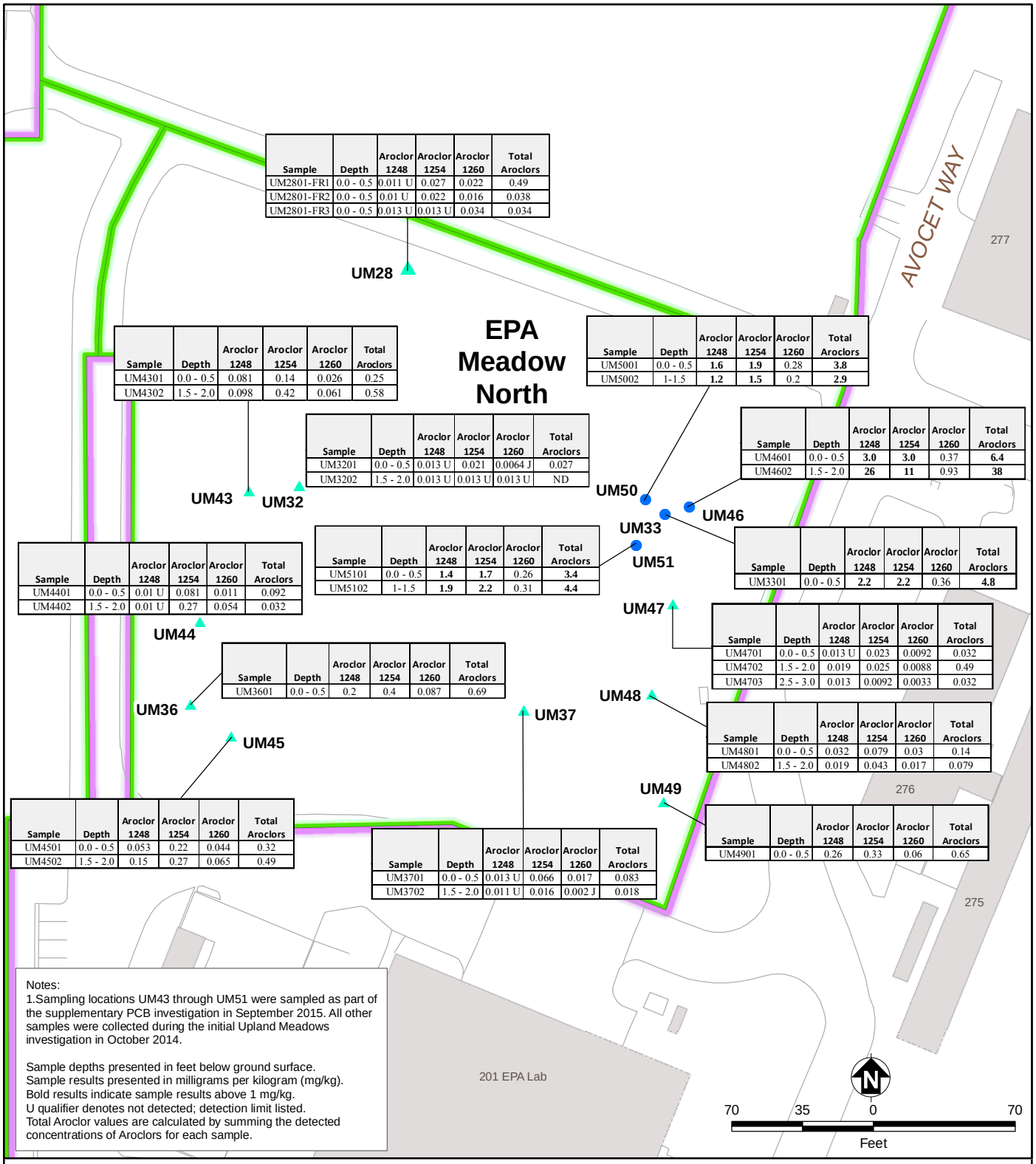
FIGURE 12
SHALLOW GROUNDWATER ELEVATION CONTOURS, APRIL 1, 2015

Phase IV Sampling Results Technical Memorandum



Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM2801-FR1	0.0 - 0.5	0.011 U	0.027	0.022	0.49
UM2801-FR2	0.0 - 0.5	0.01 U	0.022	0.016	0.038
UM2801-FR3	0.0 - 0.5	0.013 U	0.013 U	0.034	0.034

Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM4301	0.0 - 0.5	0.081	0.14	0.026	0.25
UM4302	1.5 - 2.0	0.098	0.42	0.061	0.58

Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM5001	0.0 - 0.5	**1.6**	**1.9**	0.28	**3.8**
UM5002	1-1.5	**1.2**	**1.5**	0.2	**2.9**

Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM3201	0.0 - 0.5	0.013 U	0.021	0.0064 J	0.027
UM3202	1.5 - 2.0	0.013 U	0.013 U	0.013 U	ND

Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM4601	0.0 - 0.5	**3.0**	**3.0**	0.37	**6.4**
UM4602	1.5 - 2.0	**26**	**11**	0.93	**38**

Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM4401	0.0 - 0.5	0.01 U	0.081	0.011	0.092
UM4402	1.5 - 2.0	0.01 U	0.27	0.054	0.032

Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM5101	0.0 - 0.5	**1.4**	**1.7**	0.26	**3.4**
UM5102	1-1.5	**1.9**	**2.2**	0.31	**4.4**

Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM3301	0.0 - 0.5	**2.2**	**2.2**	0.36	**4.8**

Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM4701	0.0 - 0.5	0.013 U	0.023	0.0092	0.032
UM4702	1.5 - 2.0	0.019	0.025	0.0088	0.49
UM4703	2.5 - 3.0	0.013	0.0092	0.0033	0.032

Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM3601	0.0 - 0.5	0.2	0.4	0.087	0.69

Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM4801	0.0 - 0.5	0.032	0.079	0.03	0.14
UM4802	1.5 - 2.0	0.019	0.043	0.017	0.079

Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM4501	0.0 - 0.5	0.053	0.22	0.044	0.32
UM4502	1.5 - 2.0	0.15	0.27	0.065	0.49

Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM4901	0.0 - 0.5	0.26	0.33	0.06	0.65

Sample	Depth	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total Aroclors
UM3701	0.0 - 0.5	0.013 U	0.066	0.017	0.083
UM3702	1.5 - 2.0	0.011 U	0.016	0.002 J	0.018

Notes:
1.Sampling locations UM43 through UM51 were sampled as part of the supplementary PCB investigation in September 2015. All other samples were collected during the initial Upland Meadows investigation in October 2014.

Sample depths presented in feet below ground surface.
Sample results presented in milligrams per kilogram (mg/kg).
Bold results indicate sample results above 1 mg/kg.
U qualifier denotes not detected; detection limit listed.
Total Aroclor values are calculated by summing the detected concentrations of Aroclors for each sample.

Soil Sampling Location, Total Aroclor ≤ TSCA self-implementing cleanup criterion of 1 mg/kg

Soil Sampling Location, Total Aroclor > TSCA self-implementing cleanup criterion of 1 mg/kg[1]

Designated Natural Open Space

Meadow Boundary

Existing Buildings

Asphalt/Concrete Pads

Roads and Other Landscape Features

J	Estimated result
mg/kg	Milligram per kilogram
ND	Not detected
PCB	Polychlorinated biphenyl
U	Non detect result

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Richmond Field Station Site
University of California, Berkeley

FIGURE 13
EPA MEADOW NORTH SUPPLEMENTARY PCB SAMPLING RESULTS

Phase IV Sampling Results Technical Memorandum

TABLES

Table 1: Sampling Registry

Phase IV Sampling Results, Technical Memorandum

University of California, Berkeley, Richmond Field Station Site

Sample Information				Analysis					
Point Location ID	Sample ID	Sample Date	Depth (feet bgs)	Metals (EPA Method 6020A/ 7400 series)	PAH (EPA Method 8270-SIM)	PCB (EPA Method 8082)	Pest-icides (EPA Method 8081A)	VOCs (EPA Method 8260B)	VOCs in Soil Gas (EPA Method 8260C)
Upland Meadows Soil Sampling Locations									
UM01	UM0101	10/20/2014	0.0 - 0.5	X	X	X	X		
UM01	UM0102	10/20/2014	1.5 - 2.0	X	X	X	X	X	
UM02	UM0201	10/20/2014	0.0 - 0.5	X	X	X			
UM03	UM0301	10/20/2014	0.0 - 0.5	X	X	X	X		
UM0401-FR1	UM04-R1	10/20/2014	0.0 - 0.5	X	X	X			
UM0401-FR2	UM04-R2	10/20/2014	0.0 - 0.5	X	X	X			
UM0401-FR3	UM04-R3	10/20/2014	0.0 - 0.5	X	X	X			
UM0402-FR1	UM04-R1	10/20/2014	1.5 - 2.0	X	X	X		X	
UM0402-FR2	UM04-R2	10/20/2014	1.5 - 2.0	X	X	X		X	
UM0402-FR3	UM04-R3	10/20/2014	1.5 - 2.0	X	X	X		X	
UM05	UM0501	10/20/2014	0.0 - 0.5	X	X	X			
UM05	UM0502	10/20/2014	1.5 - 2.0	X	X	X		X	
UM06	UM0601	10/20/2014	0.0 - 0.5	X	X	X			
UM07	UM0701	10/20/2014	0.0 - 0.5	X	X	X			
UM07	UM0702	10/20/2014	1.5 - 2.0	X	X	X		X	
UM08	UM0801	10/20/2014	0.0 - 0.5	X	X	X			
UM09	UM0901	10/20/2014	0.0 - 0.5	X	X	X	X		
UM10	UM1001	10/20/2014	0.0 - 0.5	X	X	X			
UM10	UM1002	10/20/2014	1.5 - 2.0	X	X	X		X	
UM11	UM1101	10/20/2014	0.0 - 0.5	X	X	X			
UM12	UM1201	10/20/2014	0.0 - 0.5	X	X	X			
UM12	UM1202	10/20/2014	1.5 - 2.0	X	X	X		X	
UM13	UM1301	10/20/2014	0.0 - 0.5	X	X	X			
UM14	UM1401	10/20/2014	0.0 - 0.5	X	X	X			
UM14	UM1402	10/20/2014	1.5 - 2.0	X	X	X		X	
UM15	UM1501	10/20/2014	0.0 - 0.5	X	X	X			
UM16	UM1601	10/20/2014	0.0 - 0.5	X	X	X			
UM16	UM1602	10/20/2014	1.5 - 2.0	X	X	X		X	
UM17	UM1701	10/26/2011	0.0 - 0.5	X	X	X			
UM18	UM1801	10/20/2014	0.0 - 0.5	X	X	X			
UM18	UM1802	10/20/2014	1.5 - 2.0	X	X	X		X	
UM1901-FR1	UM19-R1	10/20/2014	0.0 - 0.5	X	X	X			
UM1901-FR2	UM19-R2	10/20/2014	0.0 - 0.5	X	X	X			
UM1901-FR3	UM19-R3	10/20/2014	0.0 - 0.5	X	X	X			
UM20	UM2001	10/20/2014	0.0 - 0.5	X	X	X	X		
UM21	UM2101	10/20/2014	0.0 - 0.5	X	X	X			
UM21	UM2102	10/20/2014	1.5 - 2.0	X	X	X		X	
UM22	UM2201	10/20/2014	0.0 - 0.5	X	X	X			
UM23	UM2301	10/20/2014	0.0 - 0.5	X	X	X			
UM23	UM2302	10/20/2014	1.5 - 2.0	X	X	X		X	
UM24	UM2401	10/20/2014	0.0 - 0.5	X	X	X			
UM25	UM2501	10/20/2014	0.0 - 0.5	X	X	X			
UM25	UM2502	10/20/2014	1.5 - 2.0	X	X	X		X	
UM26	UM2601	10/22/2014	0.0 - 0.5	X	X	X			
UM27	UM2701	10/22/2014	0.0 - 0.5	X	X	X			

Table 1: Sampling Registry
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample Information				Analysis					
Point Location ID	Sample ID	Sample Date	Depth (feet bgs)	Metals (EPA Method 6020A/ 7400 series)	PAH (EPA Method 8270-SIM)	PCB (EPA Method 8082)	Pest-icides (EPA Method 8081A)	VOCs (EPA Method 8260B)	VOCs in Soil Gas (EPA Method 8260C)
Upland Meadows Soil Sampling Locations (Continued)									
UM27	UM2702	10/22/2014	1.5 - 2.0	X	X	X		X	
UM2801-FR1	UM28-R1	10/22/2014	0.0 - 0.5	X	X	X	X		
UM2801-FR2	UM28-R2	10/22/2014	0.0 - 0.5	X	X	X	X		
UM2801-FR3	UM28-R3	10/22/2014	0.0 - 0.5	X	X	X	X		
UM2901	UM29	10/22/2014	0.0 - 0.5	X	X	X			
UM2902	UM29	10/22/2014	1.5 - 2.0	X	X	X		X	
UM3001-FR1	UM30-R1	10/22/2014	0.0 - 0.5	X	X	X			
UM3001-FR2	UM30-R2	10/22/2014	0.0 - 0.5	X	X	X			
UM3001-FR3	UM30-R3	10/22/2014	0.0 - 0.5	X	X	X			
UM3002-FR1	UM30-R1	10/22/2014	1.5 - 2.0	X	X	X		X	
UM3002-FR2	UM30-R2	10/22/2014	1.5 - 2.0	X	X	X		X	
UM3002-FR3	UM30-R3	10/22/2014	1.5 - 2.0	X	X	X		X	
UM31	UM3101	10/22/2014	0.0 - 0.5	X	X	X			
UM32	UM3201	10/22/2014	0.0 - 0.5	X	X	X			
UM32	UM3202	10/22/2014	1.5 - 2.0	X	X	X		X	
UM33	UM3301	10/22/2014	0.0 - 0.5	X	X	X			
UM34	UM3401	10/22/2014	0.0 - 0.5	X	X	X			
UM35	UM3501	10/22/2014	0.0 - 0.5	X	X	X			
UM35	UM3502	10/22/2014	1.5 - 2.0	X	X	X		X	
UM36	UM3601	10/22/2014	0.0 - 0.5	X	X	X			
UM37	UM3701	10/22/2014	0.0 - 0.5	X	X	X			
UM37	UM3702	10/22/2014	1.5 - 2.0	X	X	X		X	
UM38	UM3801	10/22/2014	0.0 - 0.5	X	X	X			
UM38	UM3802	10/22/2014	1.5 - 2.0	X	X	X		X	
UM39	UM3901	10/22/2014	0.0 - 0.5	X	X	X			
UM39	UM3902	10/22/2014	1.5 - 2.0	X	X	X		X	
UM40	UM4001	10/22/2014	0.0 - 0.5	X	X	X			
UM41	UM4101	10/22/2014	0.0 - 0.5	X	X	X			
UM42	UM4201	10/22/2014	0.0 - 0.5	X	X	X			
UM42	UM4202	10/22/2014	1.5 - 2.0	X	X	X		X	
UM43	UM4301	9/8/2015	0.0 - 0.5			X			
UM43	UM4302	9/8/2015	1.5 - 2.0			X			
UM44	UM4401	9/8/2015	0.0 - 0.5			X			
UM44	UM4402	9/8/2015	1.5 - 2.0			X			
UM45	UM4501	9/8/2015	0.0 - 0.5			X			
UM45	UM4502	9/8/2015	1.5 - 2.0			X			
UM46	UM4601	9/8/2015	0.0 - 0.5			X			
UM46	UM4602	9/8/2015	1.5 - 2.0			X			
UM47	UM4701	9/8/2015	0.0 - 0.5			X			
UM47	UM4702	9/8/2015	1.5 - 2.0			X			
UM47	UM4703	9/8/2015	2.5 - 3.0			X			
UM48	UM4801	9/8/2015	0.0 - 0.5			X			
UM48	UM4802	9/8/2015	1.5 - 2.0			X			
UM49	UM4901	9/8/2015	0.0 - 0.5			X			
UM50	UM5001	9/8/2015	0.0 - 0.5			X			
UM50	UM5002	9/8/2015	1.0 - 1.0			X			
UM51	UM5101	9/8/2015	0.0 - 0.5			X			
UM51	UM5102	9/8/2015	1.0 - 1.0			X			

Table 1: Sampling Registry

Phase IV Sampling Results, Technical Memorandum

University of California, Berkeley, Richmond Field Station Site

Sample Information				Analysis					
Point Location ID	Sample ID	Sample Date	Depth (feet bgs)	Metals (EPA Method 6020A/ 7400 series)	PAH (EPA Method 8270-SIM)	PCB (EPA Method 8082)	Pest-icides (EPA Method 8081A)	VOCs (EPA Method 8260B)	VOCs in Soil Gas (EPA Method 8260C)
Carbon Tetrachloride Source Area Passive Soil Gas Sampling Locations									
SGCT1	SGCT1	10/30/2014	2.0 - 3.0						X
SGCT2	SGCT2	10/30/2014	2.0 - 3.0						X
SGCT3	SGCT3	10/30/2014	2.0 - 3.0						X
SGCT4	SGCT4	10/30/2014	2.0 - 3.0						X
SGCT5	SGCT5	10/30/2014	2.0 - 3.0						X
SGCT6	SGCT6	10/30/2014	2.0 - 3.0						X
SGCT7-R1	SGCT7-R1	10/30/2014	2.0 - 3.0						X
SGCT7-R2	SGCT7-R2	10/30/2014	2.0 - 3.0						X
SGCT7-R3	SGCT7-R3	10/30/2014	2.0 - 3.0						X
SGCT8	SGCT8	10/30/2014	2.0 - 3.0						X
SGCT9	SGCT9	10/30/2014	2.0 - 3.0						X
SGCT10	SGCT10	10/30/2014	2.0 - 3.0						X
Carbon Tetrachloride Source Area Passive Soil Gas Sampling Locations (Continued)									
SGCT11	SGCT11	10/30/2014	2.0 - 3.0						X
SGCTG12	SGCTG12	10/30/2014	2.0 - 3.0						X
SGCT13	SGCT13	10/30/2014	2.0 - 3.0						X
SGCT14	SGCT14	10/30/2014	2.0 - 3.0						X
SGCT15	SGCT15	10/30/2014	2.0 - 3.0						X
SGCT16	SGCT16	10/30/2014	2.0 - 3.0						X
SGCT17	SGCT17	10/30/2014	2.0 - 3.0						X
SGCT18	SGCT18	10/30/2014	2.0 - 3.0						X
SGCT19	SGCT19	10/30/2014	2.0 - 3.0						X
SGCT20	SGCT20	10/30/2014	2.0 - 3.0						X
SGCT21	SGCT21	10/30/2014	2.0 - 3.0						X
SGCT22-R1	SGCT22-R1	10/30/2014	2.0 - 3.0						X
SGCT22-R2	SGCT22-R2	10/30/2014	2.0 - 3.0						X
SGCT22-R3	SGCT22-R3	10/30/2014	2.0 - 3.0						X
SGCT23	SGCT23	10/30/2014	2.0 - 3.0						X
SGCT24	SGCT24	10/30/2014	2.0 - 3.0						X
SGCT25	SGCT25	10/30/2014	2.0 - 3.0						X
SGCT26	SGCT26	10/30/2014	2.0 - 3.0						X
SGCT27-R1	SGCT27-R1	10/30/2014	2.0 - 3.0						X
SGCT27-R2	SGCT27-R2	10/30/2014	2.0 - 3.0						X
SGCT27-R3	SGCT27-R3	10/30/2014	2.0 - 3.0						X
SGCT28	SGCT28	10/30/2014	2.0 - 3.0						X
SGCT29	SGCT29	10/30/2014	2.0 - 3.0						X
SGCT30	SGCT30	10/30/2014	2.0 - 3.0						X
SGCT31	SGCT31	10/30/2014	2.0 - 3.0						X
SGCT32	SGCT32	10/30/2014	2.0 - 3.0						X
BAPB Area Groundwater Sampling Locations									
ETA01	20150202ETA01GW01	2/2/2015	5-15	X				X	
ETA02	20150202ETA02GW01	2/2/2015	15-20	X				X	
ETA02	20150202ETA02GW01D	2/2/2015	15-20	X				X	
ETA03	20150202ETA03GW01	2/2/2015	15-20	X				X	
WSM01	20150202WSM01GW01	2/2/2015	5-15	X				X	

Notes:

Holding time listed is preservation/extraction by the lab.

Table 1: Sampling Registry

Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Preservation: All soil samples must be put on ice in coolers after collection and shipped to the lab maintaining a temperature of 4°C + 2°C. Soil gas samples do not need to be shipped on ice.

BAPB	Biologically active permeable barrier
bgs	Below ground surface
EPA	U.S. Environmental Protection Agency
ID	Identification
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
VOC	Volatile organic compound

Table 2: BAPB Area Piezometer Completion Summary
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Piezometer Name	Well Installation Date	Total Depth (ft bgs)	Casing Diameter (inches)	Screen Interval (ft bgs)	Development Date	Development Gallons Purged	Initial Sampling Date	TOC (a)
ETA01	1/28/15	15	2.0 PVC	5-15	1/30/15	115	2/2/15	5.93
ETA02	1/28/15	20	2.0 PVC	15-20	1/30/15	75	2/2/15	9.53
ETA03	1/28/15	20	2.0 PVC	15-20	1/30/15	15	2/2/15	10.48
WSM01	1/28/15	15	2.0 PVC	5-15	1/30/15	35	2/2/15	7.83

Notes:
Total depth of boring assumed to be bottom of screen unless otherwise specified on boring log or well completion form.
(a) Ground surface elevation and TOC given in feet above mean sea level (NGVD29).

ft bgs Feet below ground surface
NGVD National Geodedic Vertical Datum
PVC Polyvinyl chloride
TBD Piezometer TOC and approximate ground surface elevation to be surveyed in late March 2015.
TOC Top of casing
unk Unknown

Table 3: BAPB Area Groundwater Sampling Parameters Summary
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Point Location ID	Date	pH	Temperature (C)	Specific Conductance (µmhos/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	TDS (g/L)	Salinity (ppt)
ETA01	2/2/2015	6.56	16.91	2,120	3.50	0.42	124	1.35	1.1
ETA02	2/2/2015	5.99	18.17	4,520	23.0	0.88	115	2.89	2.4
ETA03	2/2/2015	5.49	18.17	5,390	22.6	1.61	78	3.40	2.9
WSM01	2/2/2015	5.79	18.61	2,340	53.0	0.27	44	1.50	1.2

Notes:

--	Not sampled
µmhos/cm	Micromhms per centimeter
C	Celsius
DO	Dissolved Oxygen
g/L	Grams per liter
ID	Identification
mg/L	Milligrams per liter
mV	Millivolts
NTU	Nephelometric Turbidity Units
ORP	Oxidation reduction potential
ppt	Parts per thousand
TDS	Total dissolved solids

Table 4: Upland Meadows Triplicate Soil Sampling Data and Percent Relative Standard Deviation
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Analytical Group	Analyte	Location	Sample	Field Replicate 1	Field Replicate 2	Field Replicate 3	%RSD
Metal	Aluminum	UM04	UM0401	26000	20000	25000	13.6
Metal	Aluminum	UM04	UM0402	26000	26000	27000	2.2
Metal	Aluminum	UM19	UM1901	15000	17000	20000	14.5
Metal	Aluminum	UM28	UM2801	12000	15000	15000	12.4
Metal	Aluminum	UM30	UM3001	19000	20000	19000	3.0
Metal	Aluminum	UM30	UM3002	20000	20000	19000	2.9
Metal	Antimony	UM04	UM0401	0.42	0.62	0.64	21.7
Metal	Antimony	UM04	UM0402	0.33	0.28	0.39	16.5
Metal	Antimony	UM19	UM1901	0.27	0.61	0.51	37.7
Metal	Antimony	UM28	UM2801	0.37	0.4	0.35	6.7
Metal	Antimony	UM30	UM3001	0.22	0.28	0.26	12.1
Metal	Antimony	UM30	UM3002	0.17	0.16	0.13	13.6
Metal	Arsenic	UM04	UM0401	7.5	7.8	8	3.2
Metal	Arsenic	UM04	UM0402	5.2	5.8	9.8	36.1
Metal	Arsenic	UM19	UM1901	6.5	7.6	6.8	8.2
Metal	Arsenic	UM28	UM2801	7.7	7.2	7.3	3.6
Metal	Arsenic	UM30	UM3001	5.7	6.4	6.1	5.8
Metal	Arsenic	UM30	UM3002	4.6	3.5	4	13.7
Metal	Barium	UM04	UM0401	260	180	190	20.8
Metal	Barium	UM04	UM0402	160	170	420	58.9
Metal	Barium	UM19	UM1901	180	170	170	3.3
Metal	Barium	UM28	UM2801	280	180	180	27.1
Metal	Barium	UM30	UM3001	170	170	210	12.6
Metal	Barium	UM30	UM3002	150	150	160	3.8
Metal	Beryllium	UM04	UM0401	0.67	0.56	0.69	10.9
Metal	Beryllium	UM04	UM0402	0.73	0.72	0.78	4.3
Metal	Beryllium	UM19	UM1901	0.38	0.64	0.59	25.7
Metal	Beryllium	UM28	UM2801	0.52	0.5	0.49	3.0
Metal	Beryllium	UM30	UM3001	0.6	0.58	0.58	2.0
Metal	Beryllium	UM30	UM3002	0.6	0.64	0.64	3.7
Metal	Cadmium	UM04	UM0401	0.11	0.29	0.22	43.9
Metal	Cadmium	UM19	UM1901	0.28	0.25	0.23	9.9
Metal	Cadmium	UM28	UM2801	0.23	0.2	0.15	20.9
Metal	Cadmium	UM30	UM3001	0.21	0.32	0.28	20.6
Metal	Cadmium	UM30	UM3002	0.11	0.14	0.095	19.9
Metal	Calcium	UM04	UM0401	4100	3800	4000	3.9
Metal	Calcium	UM04	UM0402	4000	4100	4000	1.4
Metal	Calcium	UM19	UM1901	4300	5100	4900	8.7
Metal	Calcium	UM28	UM2801	2100	2300	2100	5.3
Metal	Calcium	UM30	UM3001	16000	13000	7500	35.4
Metal	Calcium	UM30	UM3002	5800	4400	4300	17.4
Metal	Chromium	UM04	UM0401	63	54	64	9.1

Table 4: Upland Meadows Triplicate Soil Sampling Data and Percent Relative Standard Deviation
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Analytical Group	Analyte	Location	Sample	Field Replicate 1	Field Replicate 2	Field Replicate 3	%RSD
Metal	Chromium	UM04	UM0402	61	65	70	6.9
Metal	Chromium	UM19	UM1901	160	59	54	65.7
Metal	Chromium	UM28	UM2801	40	43	44	4.9
Metal	Chromium	UM30	UM3001	51	52	52	1.1
Metal	Chromium	UM30	UM3002	54	53	49	5.1
Metal	Cobalt	UM04	UM0401	18	17	9.8	30.0
Metal	Cobalt	UM04	UM0402	5.9	7.1	63	128.8
Metal	Cobalt	UM19	UM1901	23	14	13	33.0
Metal	Cobalt	UM28	UM2801	40	14	11	73.6
Metal	Cobalt	UM30	UM3001	12	12	18	24.7
Metal	Cobalt	UM30	UM3002	11	10	12	9.1
Metal	Copper	UM04	UM0401	24	30	30	12.4
Metal	Copper	UM04	UM0402	22	21	26	11.5
Metal	Copper	UM19	UM1901	28	36	29	14.1
Metal	Copper	UM28	UM2801	25	24	21	8.9
Metal	Copper	UM30	UM3001	25	31	29	10.8
Metal	Copper	UM30	UM3002	22	25	22	7.5
Metal	Iron	UM04	UM0401	25000	21000	24000	8.9
Metal	Iron	UM04	UM0402	23000	25000	24000	4.2
Metal	Iron	UM19	UM1901	23000	23000	21000	5.2
Metal	Iron	UM28	UM2801	17000	17000	17000	0.0
Metal	Iron	UM30	UM3001	21000	22000	22000	2.7
Metal	Iron	UM30	UM3002	20000	19000	17000	8.2
Metal	Lead	UM04	UM0401	19	53	37	46.8
Metal	Lead	UM04	UM0402	13	9.6	16	24.9
Metal	Lead	UM19	UM1901	25	35	34	17.6
Metal	Lead	UM28	UM2801	33	34	21	24.7
Metal	Lead	UM30	UM3001	12	16	15	14.5
Metal	Lead	UM30	UM3002	9.8	11	9.9	6.5
Metal	Magnesium	UM04	UM0401	4000	3300	3800	9.7
Metal	Magnesium	UM04	UM0402	4600	4700	4500	2.2
Metal	Magnesium	UM19	UM1901	20000	4000	4300	97.0
Metal	Magnesium	UM28	UM2801	2200	2600	2600	9.4
Metal	Magnesium	UM30	UM3001	5200	4900	4700	5.1
Metal	Magnesium	UM30	UM3002	3200	3200	2800	7.5
Metal	Manganese	UM04	UM0401	830	840	380	38.5
Metal	Manganese	UM04	UM0402	260	270	2900	133.1
Metal	Manganese	UM19	UM1901	760	550	640	16.2
Metal	Manganese	UM28	UM2801	2500	810	780	72.2
Metal	Manganese	UM30	UM3001	690	570	1200	40.8
Metal	Manganese	UM30	UM3002	580	550	560	2.7
Metal	Mercury	UM04	UM0401	0.2	0.33	0.23	26.9

Table 4: Upland Meadows Triplicate Soil Sampling Data and Percent Relative Standard Deviation
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Analytical Group	Analyte	Location	Sample	Field Replicate 1	Field Replicate 2	Field Replicate 3	%RSD
Metal	Mercury	UM04	UM0402	0.085	0.09	0.06	20.5
Metal	Mercury	UM19	UM1901	0.41	0.43	0.49	9.4
Metal	Mercury	UM30	UM3001	0.12	0.15	0.1	20.4
Metal	Mercury	UM30	UM3002	0.068	0.079	0.1	19.7
Metal	Molybdenum	UM04	UM0401	0.36	0.53	0.42	19.7
Metal	Molybdenum	UM04	UM0402	0.22	0.17	0.55	65.9
Metal	Molybdenum	UM19	UM1901	0.41	0.5	0.38	14.5
Metal	Molybdenum	UM28	UM2801	0.53	0.57	0.35	24.2
Metal	Molybdenum	UM30	UM3001	0.31	0.31	0.47	25.4
Metal	Molybdenum	UM30	UM3002	0.29	0.29	0.25	8.3
Metal	Nickel	UM04	UM0401	50	46	45	5.6
Metal	Nickel	UM04	UM0402	49	55	77	24.4
Metal	Nickel	UM19	UM1901	280	55	52	101.4
Metal	Nickel	UM28	UM2801	41	37	32	12.3
Metal	Nickel	UM30	UM3001	57	52	69	14.7
Metal	Nickel	UM30	UM3002	39	38	33	8.8
Metal	Potassium	UM04	UM0401	850	1100	1100	14.2
Metal	Potassium	UM04	UM0402	740	700	680	4.3
Metal	Potassium	UM19	UM1901	870	1300	850	25.3
Metal	Potassium	UM28	UM2801	630	560	590	5.9
Metal	Potassium	UM30	UM3001	940	980	1100	8.3
Metal	Potassium	UM30	UM3002	580	580	520	6.2
Metal	Selenium	UM04	UM0401	0.14	0.18	0.18	13.9
Metal	Selenium	UM04	UM0402	0.16	0.13	0.16	11.5
Metal	Selenium	UM19	UM1901	0.13	0.21	0.12	32.2
Metal	Selenium	UM28	UM2801	0.17	0.16	0.17	3.5
Metal	Selenium	UM30	UM3001	0.095	0.11	0.12	11.6
Metal	Selenium	UM30	UM3002	0.13	0.14	0.13	4.3
Metal	Silver	UM04	UM0401	0.095	0.12	0.14	19.1
Metal	Silver	UM04	UM0402	0.11	0.11	0.097	7.1
Metal	Silver	UM19	UM1901	0.071	0.12	0.084	27.7
Metal	Silver	UM28	UM2801	0.067	0.054	0.061	10.7
Metal	Silver	UM30	UM3001	0.086	0.094	0.081	7.5
Metal	Silver	UM30	UM3002	0.063	0.09	0.06	23.3
Metal	Sodium	UM04	UM0401	190	140	140	18.4
Metal	Sodium	UM04	UM0402	270	330	320	10.5
Metal	Sodium	UM19	UM1901	140	160	140	7.9
Metal	Sodium	UM28	UM2801	300	320	270	8.5
Metal	Sodium	UM30	UM3001	140	140	150	4.0
Metal	Sodium	UM30	UM3002	140	200	140	21.7
Metal	Thallium	UM04	UM0401	0.12	0.11	0.13	8.3
Metal	Thallium	UM04	UM0402	0.12	0.12	0.18	24.7

Table 4: Upland Meadows Triplicate Soil Sampling Data and Percent Relative Standard Deviation
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Analytical Group	Analyte	Location	Sample	Field Replicate 1	Field Replicate 2	Field Replicate 3	%RSD
Metal	Thallium	UM19	UM1901	0.084	0.1	0.1	9.8
Metal	Thallium	UM28	UM2801	0.11	0.093	0.091	10.7
Metal	Thallium	UM30	UM3001	0.1	0.11	0.12	9.1
Metal	Thallium	UM30	UM3002	0.099	0.1	0.089	6.3
Metal	Vanadium	UM04	UM0401	57	49	55	7.8
Metal	Vanadium	UM04	UM0402	48	53	70	20.2
Metal	Vanadium	UM19	UM1901	40	47	42	8.4
Metal	Vanadium	UM28	UM2801	44	41	39	6.1
Metal	Vanadium	UM30	UM3001	40	41	42	2.4
Metal	Vanadium	UM30	UM3002	40	35	34	8.8
Metal	Zinc	UM04	UM0401	43	71	66	24.9
Metal	Zinc	UM04	UM0402	36	35	39	5.7
Metal	Zinc	UM19	UM1901	79	72	67	8.3
Metal	Zinc	UM28	UM2801	45	46	43	3.4
Metal	Zinc	UM30	UM3001	54	75	67	16.2
Metal	Zinc	UM30	UM3002	39	45	35	12.7
PAH	Anthracene	UM28	UM2801	0.0019	0.0023	0.0012	30.9
PAH	Benzo(a)Anthracene	UM04	UM0401	0.0031	0.011	0.0055	62.0
PAH	Benzo(a)Anthracene	UM19	UM1901	0.0067	0.046	0.014	94.0
PAH	Benzo(a)Anthracene	UM30	UM3001	0.0024	0.007	0.0019	74.6
PAH	Benzo(a)Pyrene	UM04	UM0401	0.0041	0.014	0.0066	62.5
PAH	Benzo(a)Pyrene	UM19	UM1901	0.0088	0.041	0.017	75.2
PAH	Benzo(a)Pyrene	UM28	UM2801	0.013	0.012	0.0085	21.2
PAH	Benzo(a)Pyrene	UM30	UM3001	0.0028	0.0075	0.0024	67.0
PAH	Benzo(b)Fluoranthene	UM04	UM0401	0.0059	0.03	0.012	78.5
PAH	Benzo(b)Fluoranthene	UM04	UM0402	0.0013	0.0034	0.0019	49.2
PAH	Benzo(b)Fluoranthene	UM19	UM1901	0.017	0.05	0.027	54.0
PAH	Benzo(b)Fluoranthene	UM28	UM2801	0.032	0.023	0.023	20.0
PAH	Benzo(b)Fluoranthene	UM30	UM3001	0.0042	0.012	0.0049	61.4
PAH	Benzo(g,h,i)Perylene	UM04	UM0401	0.0086	0.021	0.013	44.3
PAH	Benzo(g,h,i)Perylene	UM19	UM1901	0.0061	0.011	0.013	35.4
PAH	Benzo(g,h,i)Perylene	UM28	UM2801	0.051	0.035	0.037	21.3
PAH	Benzo(g,h,i)Perylene	UM30	UM3001	0.0047	0.0049	0.0026	31.3
PAH	Benzo(k)Fluoranthene	UM04	UM0401	0.0043	0.0071	0.007	25.9
PAH	Benzo(k)Fluoranthene	UM19	UM1901	0.0052	0.017	0.013	51.1
PAH	Benzo(k)Fluoranthene	UM28	UM2801	0.0076	0.0052	0.0048	25.8
PAH	Benzo(k)Fluoranthene	UM30	UM3001	0.0026	0.0041	0.0016	45.5
PAH	Chrysene	UM04	UM0401	0.0062	0.022	0.014	56.2
PAH	Chrysene	UM04	UM0402	0.0012	0.0027	0.0017	40.9
PAH	Chrysene	UM19	UM1901	0.012	0.044	0.022	63.0
PAH	Chrysene	UM28	UM2801	0.018	0.02	0.014	17.6
PAH	Chrysene	UM30	UM3001	0.0043	0.0098	0.0035	58.5

Table 4: Upland Meadows Triplicate Soil Sampling Data and Percent Relative Standard Deviation
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Analytical Group	Analyte	Location	Sample	Field Replicate 1	Field Replicate 2	Field Replicate 3	%RSD
PAH	Dibenz(a,h)Anthracene	UM19	UM1901	0.0015	0.0034	0.0034	39.6
PAH	Fluoranthene	UM04	UM0401	0.013	0.031	0.023	40.4
PAH	Fluoranthene	UM04	UM0402	0.0015	0.0038	0.0024	45.2
PAH	Fluoranthene	UM19	UM1901	0.019	0.087	0.047	67.0
PAH	Fluoranthene	UM28	UM2801	0.021	0.027	0.018	20.8
PAH	Fluoranthene	UM30	UM3001	0.0069	0.014	0.005	54.9
PAH	Indeno(1,2,3-Cd)Pyrene	UM04	UM0401	0.0041	0.01	0.0062	44.2
PAH	Indeno(1,2,3-Cd)Pyrene	UM19	UM1901	0.0048	0.011	0.01	38.7
PAH	Indeno(1,2,3-Cd)Pyrene	UM30	UM3001	0.0024	0.0036	0.0015	42.1
PAH	Phenanthrene	UM04	UM0401	0.0045	0.015	0.0097	53.9
PAH	Phenanthrene	UM19	UM1901	0.011	0.034	0.021	52.4
PAH	Phenanthrene	UM28	UM2801	0.0098	0.013	0.0083	23.2
PAH	Phenanthrene	UM30	UM3001	0.0026	0.0049	0.0028	37.1
PAH	Pyrene	UM04	UM0401	0.0073	0.027	0.013	64.3
PAH	Pyrene	UM04	UM0402	0.0015	0.0037	0.002	48.1
PAH	Pyrene	UM19	UM1901	0.016	0.08	0.031	79.1
PAH	Pyrene	UM28	UM2801	0.019	0.022	0.017	13.0
PAH	Pyrene	UM30	UM3001	0.0049	0.011	0.0041	56.6
PCB	Aroclor-1254	UM04	UM0401	0.0065	0.041	0.016	84.2
PCB	Aroclor-1254	UM19	UM1901	0.039	0.024	0.013	51.5
PCB	Aroclor-1260	UM04	UM0401	0.0071	0.012	0.0056	40.7
PCB	Aroclor-1260	UM19	UM1901	0.011	0.0073	0.0074	24.6
PCB	Aroclor-1260	UM28	UM2801	0.022	0.016	0.034	38.2
Pesticide	4,4'-DDD	UM28	UM2801	0.0034	0.0013	0.001	68.8
Pesticide	4,4'-DDE	UM28	UM2801	0.0074	0.014	0.014	32.3
Pesticide	4,4'-DDT	UM28	UM2801	0.0077	0.0089	0.0068	13.5
Pesticide	Aldrin	UM28	UM2801	0.0014	0.00086	0.00077	33.7
Pesticide	Beta-BHC	UM28	UM2801	0.00043	0.00089	0.001	39.1
Pesticide	Endrin Aldehyde	UM28	UM2801	0.002	0.0028	0.00048	67.0
Pesticide	Gamma-Chlordane	UM28	UM2801	0.0012	0.00077	0.00064	33.7
Pesticide	Heptachlor	UM28	UM2801	0.00054	0.00052	0.0016	69.7

Notes:

Grey highlighted cells indicate the percent RSD for the set of three replicates is greater than 30 percent.

%	Percent
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
RSD	Relative standard deviation

TABLE 5: STATISTICAL SUMMARY OF CHEMICALS DETECTED IN UPLAND MEADOWS SOIL

Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Analyte	Detection Frequency	Minimum Detected Result	Average Detected Result	Maximum Detected Result	95UCL[a]	Location of Maximum Detected Result	Number of Locations with Detected Results	Maintenance Worker Screening Criteria[b]	Number of Samples with Results > Maintenance Worker Screening Criteria	Off-Site Receptors Screening Criteria[b]	Number of Samples with Results > Off-Site Receptors Screening Criteria	Plant Ecological Screening Criteria[c]	Number of Samples with Results > Plant Ecological Screening Criteria	Invertebrates Ecological Screening Criteria[c]	Number of Samples with Results > Invertebrates Ecological Screening Criteria	Bird Ecological Screening Criteria[c]	Number of Samples with Results > Bird Ecological Screening Criteria	Mammal Ecological Screening Criteria[c]	Number of Samples with Results > Mammal Ecological Screening Criteria	Ambient Criteria	Number of Samples with Results > Ambient Criteria
Metals (mg/kg)																					
ALUMINUM	75/75	8,500	18,400	28,000	19,354	UM07	50	100,000	0	6,860,000	0	50	75	NC	-	NC	-	NC	-	NC	-
ANTIMONY	75/75	0.13 J	0.464	4.5	0.451	UM41	50	2,720	0	NC	-	5	0	78	0	NC	-	0.27	53	NC	-
ARSENIC	75/75	3.5	6.53	51	6.2	UM41	50	1.58	75	745	0	18	1	60	0	43	1	46	1	16 d,e	1
BARIUM	75/75	110	191	490	202	UM39	50	52,600	0	686,000	0	500	0	330	2	NC	-	2,000	0	NC	-
BERYLLIUM	75/75	0.3	0.578	0.83	0.603	UM39	50	127.75	0	1,330	0	10	0	40	0	NC	-	21	0	NC	-
CADMIUM	69/75	0.061 J	0.310	6.8	0.238	UM41	50	73	0	762	0	32	0	140	0	0.77	2	0.36	6	NC	-
CALCIUM	75/75	2,100	4,670	19,000	NC	UM26	50	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-
CHROMIUM	75/75	37	53.4	160	56.4	UM19-FR1	50	100,000	0	NC	-	1	75	0.4	75	NC	-	130	1	NC	-
COBALT	75/75	3.1	15.3	73	17.5	UM39	50	34.1	3	356	0	13	32	NC	-	120	0	230	0	73 f	0
COPPER	75/75	16	28.5	170	28.7	UM41	50	100,000	0	NC	-	70	3	80	1	28	21	49	3	NC	-
IRON	75/75	12,000	21,200	95,000	20,889	UM41	50	100,000	0	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-
LEAD	75/75	5.7	24.8	89	27.4	UM40	50	320 e,g	0	NC	-	120	0	1,700	0	11	57	56	3	NC	-
MAGNESIUM	75/75	1,500	3,830	20,000	NC	UM19-FR1	50	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-
MANGANESE	75/75	120	784	5,900	1,163	UM39	50	5,300	1	68,600	0	220	74	450	62	4,300	1	4,000	1	5,900 f	0
MERCURY	74/75	0.038	0.354	2.4	0.435	UM36	49	1,920	0	412,000	0	0.3 h	28	0.1 h	54	3 h	0	4.95 h	0	NC	-
MOLYBDENUM	74/75	0.16 J	0.493	3.1	0.496	UM41	50	34,000	0	NC	-	2	1	NC	-	NC	-	NC	-	NC	-
NICKEL	75/75	20	50.6	280	57.4	UM19-FR1	50	1,180	0	12,300	0	38	51	280	0	210	1	130	2	280 f	0
POTASSIUM	75/75	400	855	2,400	NC	UM29	50	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-
SELENIUM	75/75	0.095 J	0.174	0.84	0.174	UM41	50	33,500	0	27,400,000	0	0.52	1	4.1	0	1.2	0	0.63	1	NC	-
SILVER	75/75	0.03 J	0.138	3.5	0.1	UM41	50	34,000	0	NC	-	560	0	NC	-	4.2	0	14	0	NC	-
SODIUM	75/75	29	163	350	NC	UM39	50	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-
THALLIUM	75/75	0.072 J	0.114	0.89	0.107	UM41	50	68	0	NC	-	1	0	NC	-	NC	-	NC	-	NC	-
VANADIUM	75/75	32 J	42.3	70	43.4	UM04-FR3	50	34,000	0	NC	-	2	75	NC	-	7.8	75	280	0	NC	-
ZINC	75/75	26	75.3	1,100	88.4	UM41	50	100,000	0	NC	-	160	4	120	5	46	40	79	12	NC	-
Volatile Organic Compounds (mg/kg)																					
None Detected	0/ 25	ND	ND	ND	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Semivolatile Organic Compounds (mg/kg)																					
1-METHYLNAPHTHALENE	3/75	0.0015 J	0.00243	0.0034 J	NC	UM37	3	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-
2-METHYLNAPHTHALENE	7/75	0.0013 J	0.00177	0.0038 J	NC	UM24	7	10,100	0	NC	-	20	0	NC	-	NC	-	NC	-	NC	-
ACENAPHTHENE	5/75	0.0012 J	0.0100	0.041	NC	UM36	4	100,000	0	NC	-	20	0	NC	-	NC	-	NC	-	NC	-
ACENAPHTHYLENE	4/75	0.0015 J	0.00645	0.019 J	NC	UM36	4	100,000	0	NC	-	20	0	NC	-	NC	-	NC	-	NC	-
ANTHRACENE	17/75	0.0012 J	0.00718	0.057	NC	UM36	15	100,000	0	NC	-	20	0	NC	-	NC	-	NC	-	NC	-
BENZO(A)ANTHRACENE	46/75	0.0012 J	0.0131	0.19	NC	UM36	43	5.87	0	11,500	0	NC	-	NC	-	NC	-	NC	-	NC	-
BENZO(A)PYRENE	52/75	0.0011 J	0.0146	0.17	NC	UM36	46	0.963	0	1,150	0	NC	-	NC	-	NC	-	NC	-	NC	-
BENZO(B)FLUORANTHENE	62/75	0.0013 J	0.0310	0.48	NC	UM36	47	5.87	0	11,500	0	NC	-	NC	-	NC	-	NC	-	NC	-
BENZO(G,H,I)PERYLENE	60/75	0.0014 J	0.0152	0.23	NC	UM29	48	75,600	0	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-
BENZO(K)FLUORANTHENE	47/75	0.0016 J	0.00970	0.098	NC	UM36	45	5.87	0	11,500	0	NC	-	NC	-	NC	-	NC	-	NC	-
CHRYSENE	63/75	0.0011 J	0.0177	0.24	NC	UM36	47	58.7	0	115,000	0	NC	-	NC	-	NC	-	NC	-	NC	-
DIBENZ(A,H)ANTHRACENE	21/75	0.0011 J	0.00665	0.058	NC	UM29	20	0.963	0	2,670	0	NC	-	NC	-	NC	-	NC	-	NC	-
FLUORANTHENE	63/75	0.0013 J	0.0272	0.45	NC	UM36	46	100,000	0	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-

TABLE 5: STATISTICAL SUMMARY OF CHEMICALS DETECTED IN UPLAND MEADOWS SOIL (Continued)

Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Analyte	Detection Frequency	Minimum Detected Result	Average Detected Result	Maximum Detected Result	95UCL[a]	Location of Maximum Detected Result	Number of Locations with Detected Results	Maintenance Worker Screening Criteria[b]	Number of Samples with Results > Maintenance Worker Screening Criteria	Off-Site Receptors Screening Criteria[b]	Number of Samples with Results > Off-Site Receptors Screening Criteria	Plant Ecological Screening Criteria[c]	Number of Samples with Results > Plant Ecological Screening Criteria	Invertebrates Ecological Screening Criteria[c]	Number of Samples with Results > Invertebrates Ecological Screening Criteria	Bird Ecological Screening Criteria[c]	Number of Samples with Results > Bird Ecological Screening Criteria	Mammal Ecological Screening Criteria[c]	Number of Samples with Results > Mammal Ecological Screening Criteria	Ambient Criteria	Number of Samples with Results > Ambient Criteria
Semivolatile Organic Compounds (mg/kg)																					
FLUORENE	4/75	0.0018 J	0.00698	0.022 J	NC	UM36	4	100,000	0	NC	-	20	0	30	0	NC	-	NC	-	NC	-
INDENO(1,2,3-CD)PYRENE	42/75	0.0015 J	0.0114	0.17	NC	UM29	39	5.87	0	11,500	0	NC	-	NC	-	NC	-	NC	-	NC	-
NAPHTHALENE	7/75	0.0012 J	0.00140	0.0016 J	NC	UM37	7	450	0	3.57	0	NC	-	NC	-	NC	-	NC	-	NC	-
PHENANTHRENE	55/75	0.0012 J	0.0154	0.27	NC	UM36	47	100,000	0	NC	-	20	0	NC	-	NC	-	NC	-	NC	-
PYRENE	63/75	0.0011 J	0.0241	0.43	NC	UM36	47	75,600	0	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-
BAP EQ (EPA)	64/75	0.0000016	0.0188	0.292	NC	UM29	47	0.4 i	0	0.4 i	0	NC	-	NC	-	NC	-	NC	-	0.4 i	0
PCBs/Pesticides (mg/kg)																					
PCBs																					
AROCLOR-1248	19/93	0.013	2.03	26	NC	UM46	11	1 j	7	1 j	7	NC	-	NC	-	NC	-	NC	-	NC	-
AROCLOR-1254	65/93	0.0037 J	0.422	11	NC	UM46	50	1 j	7	1 j	7	40	0	NC	-	NC	-	NC	-	NC	-
AROCLOR-1260	62/93	0.002 J	0.0604	0.93	NC	UM46	49	1 j	0	1 j	0	NC	-	NC	-	NC	-	NC	-	NC	-
Pesticides																					
4,4'-DDD	6/8	0.001 J	0.00187	0.0034 J	NC	UM28-FR1	6	52.8	0	46,400	0	NC	-	NC	-	0.093	0	0.021	0	NC	-
4,4'-DDE	8/8	0.0034 J	0.0114	0.029 J	NC	UM09	8	37.3	0	33,000	0	NC	-	NC	-	0.093	0	0.021	1	NC	-
4,4'-DDT	8/8	0.0036 J	0.0107	0.029 J	NC	UM09	8	37.3	0	33,000	0	NC	-	NC	-	0.093	0	0.021	1	NC	-
ALDRIN	3/8	0.00077 J	0.00101	0.0014 J	NC	UM28-FR1	3	0.75	0	654	0	NC	-	NC	-	NC	-	NC	-	NC	-
ALPHA-BHC	1/8	0.00047 J	0.000470	0.00047 J	NC	UM28-FR3	1	2.01	0	1,780	0	NC	-	NC	-	NC	-	NC	-	NC	-
ALPHA-CHLORDANE	2/8	0.00018 J	0.000280	0.00038 J	NC	UM28-FR1	2	9.76	0	9,420	0	NC	-	NC	-	NC	-	NC	-	NC	-
BETA-BHC	3/8	0.00043 J	0.000773	0.001 J	NC	UM28-FR3	3	7.04	0	6,040	0	NC	-	NC	-	NC	-	NC	-	NC	-
DELTA-BHC	2/8	0.00041 J	0.000630	0.00085 J	NC	UM28-FR2	2	2.01	0	1,780	0	NC	-	NC	-	NC	-	NC	-	NC	-
DIELDRIN	1/8	0.00038 J	0.000380	0.00038 J	NC	UM28-FR1	1	0.79	0	696	0	NC	-	NC	-	0.022	0	0.0049	0	NC	-
ENDOSULFAN I	2/8	0.0003 J	0.000750	0.0012 J	NC	UM28-FR3	2	27,500	0	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-
ENDOSULFAN II	1/8	0.0024 J	0.00240	0.0024 J	NC	UM28-FR2	1	27,500	0	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-
ENDOSULFAN SULFATE	3/8	0.0017 J	0.00207	0.0025 J	NC	UM20	3	27,500	0	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-
ENDRIN	2/8	0.00071 J	0.000835	0.00096 J	NC	UM28-FR1	2	1,370	0	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-
ENDRIN ALDEHYDE	4/8	0.00048 J	0.00182	0.0028 J	NC	UM28-FR2	4	1,370	0	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-
GAMMA-BHC (LINDANE)	1/8	0.00044 J	0.000440	0.00044 J	NC	UM28-FR3	1	11.5	0	10,300	0	NC	-	NC	-	NC	-	NC	-	NC	-
GAMMA-CHLORDANE	4/8	0.00046 J	0.000768	0.0012 J	NC	UM28-FR1	4	9.76	0	9,420	0	NC	-	NC	-	NC	-	NC	-	NC	-
HEPTACHLOR	3/8	0.00052 J	0.000887	0.0016 J	NC	UM28-FR3	3	2.82	0	2,460	0	NC	-	NC	-	NC	-	NC	-	NC	-
HEPTACHLOR EPOXIDE	2/8	0.00057 J	0.00114	0.0017 J	NC	UM28-FR2	2	1.39	0	1,230	0	NC	-	NC	-	NC	-	NC	-	NC	-
METHOXYCHLOR	2/8	0.0057 J	0.00985	0.014 J	NC	UM20	2	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-	NC	-

TABLE 5: STATISTICAL SUMMARY OF CHEMICALS DETECTED IN UPLAND MEADOWS SOIL (Continued)

Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Notes:

a 95UCLs calculated using the entire Upland Meadows dataset excluding the results from location UM41 which is known to be contaminated with pyrite cinders. The methods used to calculate the 95UCLs are described in Appendix G.

b Screening criteria are risk-based concentrations as calculated in Appendix C of the Site Characterization Report (Tetra Tech 2013a), with the following exceptions: arsenic, lead, Aroclors-1248, -1254, -1260, and BAP (EQ) (see notes c, e, g, and h). Risk-based concentrations are shown with 3 significant figures, except where the default value of 100,00 mg/kg applies (where calculated value exceeds 100,000 mg/kg). Risk-based concentrations shown are the minimum values between the cancer and noncancer multi-pathway risk-based concentrations. For the off-site receptor, the values shown are the minimum values between the cancer and noncancer inhalation pathway risk-based concentrations calculated for the unrestricted use scenario; off-site receptor risk-based concentrations are unavailable for chemicals that do not have toxicity values derived for the inhalation route of exposure. Criteria were not developed for essential nutrients (calcium, magnesium, potassium, or sodium).

c Ecological screening criteria are Eco-SSLs from EPA (2010) for plants, invertebrates, birds, and mammals. If an Eco-SSL is not available, ORNL phytotoxicity and earthworm toxicity benchmarks were selected (Efroymson and others 1997a, 1997b).

d The background level for arsenic (16 mg/kg) was established for the adjacent Campus Bay Site and approved by DTSC for the former RFS Site (Erler & Kalinowski, Inc. 2007; DTSC 2007). The arsenic remedial goal is a not to exceed value, except in cases where arsenic is associated with cinders in soil (see note d).

e If lead or arsenic is associated with cinders, manage on site per Section 5.2.3 of the SMP (Appendix C of the RAW, Tetra Tech 2014). If not associated with cinders, investigate further, determine if source is present, and dispose of off-site.

f Ambient concentrations, based on Final Technical Memorandum, Ambient Metals Evaluation, Aluminum, Cobalt, Manganese, Copper, December 11, 2015 (Tetra Tech 2015).

g A risk-based concentration was not calculated for lead. Rather, the industrial CHHSL of 320 mg/kg (Cal/EPA OEHHA 2009) was used for the maintenance worker scenario. A risk-based concentration for the off-site receptor pathway is not available because lead is non-volatile.

h DTSC's ERAS HERO developed screening levels for evaluation of Upland Meadows soil mercury concentrations. Screening levels are based on a soil to earthworm BAF of 1, and results in a screening level of 3.0 mg/kg for the American robin and 4.95 mg/kg for the ornate shrew.

i The ambient level for BAP (EQ) (0.4 mg/kg) is based on the 95 UCL concentration of the ambient dataset for BAP (EQ) in surface soils in Northern California (DTSC 2009; Environ Corporation and others 2002).

j Based on the TSCA High Occupancy, no further conditions threshold criterion for total PCBs from EPA (2005).

-	Not available	DDE	Dichlorodiphenyldichloroethene	mg/kg-day	Milligram per kilogram per day
95 UCL	95th percentile Upper Confidence Limit of the arithmetic mean	DDT	Dichlorodiphenyltrichloroethane	NC	No criteria
BAF	Bioaccumulation factor	DTSC	Cal/EPA, Department of Toxic Substances Control	ND	None detected
BAP (EQ)	Benzo(a)pyrene equivalent	EPA	U.S. Environmental Protection Agency	OEHHA	Office of Environmental Health Hazard Assessment
BHC	Hexachlorocyclohexane	ERAS	Ecological Risk Assessment Section	ORNL	Oak Ridge National Laboratory
Cal/EPA	California Environmental Protection Ageny	HERO	Human and Ecological Risk Office	PCB	Polychlorinated biphenyl
CHHSL	California human health screening level	J	Estimated value	SMP	Soil management plan
DDD	Dichlorodiphenyldichloroethane	mg/kg	Milligrams per kilogram	TSCA	Toxic Substances Control Act

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Table 6: Upland Meadows Soil Detected Metals Compared to Human Health Screening Criteria
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID	Sample Location	Depth (feet bgs)	Units	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CHROMIUM	COBALT	COPPER	IRON	LEAD	MANGANESE	MERCURY	MOLYBDENUM	NICKEL	SELENIUM	SILVER	THALLIUM	VANADIUM	ZINC
Category I Criteria				20,300	109	16	2,110	29	68.1	100,000	19.9	10,900	100,000	320	212	77	1,360	60.6	1,340	1,360	2.72	1,360	81,600
Category II On-Site Management Criteria				100,000	1,090	16	100,000	290	681	100,000	199	100,000	100,000	800	2,120	275	13,600	606	13,400	13,600	27.2	13,600	100,000
Maintenance Worker Screening Criteria				100,000	2,720	16	52,600	127.75	73	100,000	34.1	100,000	100,000	320	5,300	1,920	34,000	1,180	33,500	34,000	68	34,000	100,000
Off-Site Receptors Screening Criteria				6,860,000	-	16	686,000	1,330	762	-	356	-	-	-	68,600	412,000	-	12,300	27,400,000	-	-	-	-
UM0101	UM01	0.0 - 0.5	MG/KG	24,000	0.4	5.3	170	0.67	0.15 J	58	9.6	22	23,000	25	470	0.28	0.52	51	0.16 J	0.1 J	0.092 J	44	47
UM0102	UM01	1.5 - 2.0	MG/KG	26,000	0.22 J	4.7	190	0.72	0.093 J	64	12	23	25,000	11	520	0.094	0.33 J	56	0.13 J	0.092 J	0.098 J	44	37
UM0201	UM02	0.0 - 0.5	MG/KG	19,000	0.53	7.6	180	0.56	0.42	64	14	34	23,000	52	650	0.22	0.59	61	0.24 J	0.1 J	0.12 J	51	100
UM0301	UM03	0.0 - 0.5	MG/KG	24,000	0.37	4.8	180	0.67	0.13 J	57	20	24	21,000	17	790	0.31	0.31 J	48	0.16 J	0.092 J	0.095 J	44	37
UM0401-FR1	UM04-R1	0.0 - 0.5	MG/KG	26,000	0.42	7.5	260	0.67	0.11 J	63	18	24	25,000	19	830	0.2	0.36 J	50	0.14 J	0.095 J	0.12 J	57	43
UM0401-FR2	UM04-R2	0.0 - 0.5	MG/KG	20,000	0.62	7.8	180	0.56	0.29	54	17	30	21,000	53	840	0.33	0.53	46	0.18 J	0.12 J	0.11 J	49	71
UM0401-FR3	UM04-R3	0.0 - 0.5	MG/KG	25,000	0.64	8	190	0.69	0.22 J	64	9.8	30	24,000	37	380	0.23	0.42 J	45	0.18 J	0.14 J	0.13 J	55	66
UM0402-FR1	UM04-R1	1.5 - 2.0	MG/KG	26,000	0.33	5.2	160	0.73	0.061 J	61	5.9	22	23,000	13	260	0.085	0.22 J	49	0.16 J	0.11 J	0.12 J	48	36
UM0402-FR2	UM04-R2	1.5 - 2.0	MG/KG	26,000	0.28	5.8	170	0.72	0.27 U	65	7.1	21	25,000	9.6	270	0.09	0.17 J	55	0.13 J	0.11 J	0.12 J	53	35
UM0402-FR3	UM04-R3	1.5 - 2.0	MG/KG	27,000	0.39	9.8	420	0.78	0.11 J	70	63	26	24,000	16	2,900	0.06	0.55	77	0.16 J	0.097 J	0.18 J	70	39
UM0501	UM05	0.0 - 0.5	MG/KG	16,000	0.32	5.4	150	0.49	0.11 J	44	12	18	17,000	19	610	0.2	0.75	29	0.17 J	0.063 J	0.082 J	42	33
UM0502	UM05	1.5 - 2.0	MG/KG	22,000	0.2 J	4.2	150	0.49	0.26 U	51	8.1	17	20,000	6.4	410	0.059	0.54	28	0.14 J	0.059 J	0.11 J	41	28
UM0601	UM06	0.0 - 0.5	MG/KG	16,000	0.43	7.3	210	0.53	0.17 J	66	18	27	28,000	25	650	0.17	0.67	83	0.17 J	0.12 J	0.093 J	41	67
UM0701	UM07	0.0 - 0.5	MG/KG	13,000	0.34	4.8	160	0.42	0.16 J	39	9.2	20	15,000	21	590	0.33	0.29 J	28	0.15 J	0.056 J	0.076 J	37	41
UM0702	UM07	1.5 - 2.0	MG/KG	28,000	0.23 J	4.9	180	0.52	0.31 U	65	8.9	21	27,000	9.2	250	0.076	0.3 J	43	0.14 J	0.11 J	0.13 J	43	39
UM0801	UM08	0.0 - 0.5	MG/KG	21,000	0.53	5.6	170	0.58	0.082 J	54	11	20	20,000	11	530	0.22	0.33 J	33 J	0.26 J	0.066 J	0.14 J	46	34
UM0901	UM09	0.0 - 0.5	MG/KG	14,000	1.9	5	150	0.46	0.23 J	41	10	21	15,000	35	630	0.24	0.55	26	0.25 J	0.16 J	0.11 J	37	53
UM1001	UM10	0.0 - 0.5	MG/KG	12,000	0.3	4.6	150	0.45	0.18 J	38	7.7	20	14,000	27	500	0.12	0.44 J	28	0.16 J	0.086 J	0.08 J	34	40
UM1002	UM10	1.5 - 2.0	MG/KG	17,000	0.2 J	4.6	130	0.54	0.28 U	48	7.2	16	18,000	9.9	290	0.038	0.32 J	30	0.17 J	0.05 J	0.093 J	40	26
UM1101	UM11	0.0 - 0.5	MG/KG	16,000	0.88	6.2	190	0.51	0.26 J	49	12	27	18,000	31	650	0.43	0.4 J	39	0.17 J	0.07 J	0.11 J	44	84
UM1201	UM12	0.0 - 0.5	MG/KG	24,000	0.69	6.5	210	0.7	0.34	57	10	36	22,000	47	460	0.86	0.44 J	51	0.18 J	0.16 J	0.11 J	43	75
UM1202	UM12	1.5 - 2.0	MG/KG	23,000	0.18 J	4.9	240	0.7	0.076 J	52	16	22	22,000	10	650	0.25	0.5 U	53	0.12 J	0.089 J	0.074 J	37	32
UM1301	UM13	0.0 - 0.5	MG/KG	11,000	0.39	4.6	110	0.43	0.16 J	37	8.2	17	12,000	25	540	0.25	0.33 J	20	0.12 J	0.081 J	0.095 J	34	35
UM1401	UM14	0.0 - 0.5	MG/KG	13,000	0.3	4.6	190	0.45	0.13 J	41	11	19	15,000	16	700	0.23	0.32 J	34	0.15 J	0.049 J	0.085 J	37	35
UM1402	UM14	1.5 - 2.0	MG/KG	14,000	0.22 J	4.3	230	0.5	0.09 J	42	16	18	16,000	7.5	1,000	0.063	0.27 J	39	0.18 J	0.037 J	0.095 J	38	27
UM1501	UM15	0.0 - 0.5	MG/KG	23,000	0.58	6.2	170	0.62	0.29	57	15	29	23,000	33	720	0.58	0.46	39	0.19 J	0.11 J	0.11 J	46	83
UM1601	UM16	0.0 - 0.5	MG/KG	23,000	0.39	5.6	240	0.73	0.091 J	58	18	20	23,000	16	640	0.15	0.3 J	50	0.18 J	0.11 J	0.12 J	46	35
UM1602	UM16	1.5 - 2.0	MG/KG	19,000	0.59	6.3	180	0.52	0.19 J	48	15	25	19,000	42	620	0.53	0.45 J	38	0.19 J	0.11 J	0.1 J	42	49
UM1701	UM17	0.0 - 0.5	MG/KG	15,000	0.27	5.2	170	0.45	0.18 J	56	15	21	20,000	23	630	0.12	0.79	52	0.19 J	0.08 J	0.089 J	38	57
UM1801	UM18	0.0 - 0.5	MG/KG	14,000	0.67	4.7	160	0.44	0.19 J	38	8.7 J	22	14,000	24 J	600	0.71	0.41 J	25 J	0.19 J	0.1 J	0.1 J	32 J	45
UM1802	UM18	1.5 - 2.0	MG/KG	19,000	0.7	6.2	250	0.59	0.09 J	46	26	21	21,000	14	1,300	0.13	0.37 J	35	0.2 J	0.06 J	0.12 J	44	30
UM1901-FR1	UM19-R1	0.0 - 0.5	MG/KG	15,000	0.27 J	6.5	180	0.38	0.28	160	23	28	23,000	25	760	0.41	0.41 J	280	0.13 J	0.071 J	0.084 J	40	79
UM1901-FR2	UM19-R2	0.0 - 0.5	MG/KG	17,000	0.61	7.6	170	0.64	0.25 J	59	14	36	23,000	35	550	0.43	0.5	55	0.21 J	0.12 J	0.1 J	47	72
UM1901-FR3	UM19-R3	0.0 - 0.5	MG/KG	20,000	0.51	6.8	170	0.59	0.23 J	54	13	29	21,000	34	640	0.49	0.38 J	52	0.12 J	0.084 J	0.1 J	42	67
UM2001	UM20	0.0 - 0.5	MG/KG	22,000	0.48	6.3	210	0.62	0.17 J	59	22	26	21,000	26	860	0.5	0.61	36	0.2 J	0.17 J	0.12 J	47	48
UM2101	UM21	0.0 - 0.5	MG/KG	18,000	0.54	7.2	150	0.56	0.21 J	56	6	24	21,000	40	340	0.59	0.58	35	0.14 J	0.096 J	0.096 J	48	49
UM2102	UM21	1.5 - 2.0	MG/KG	25,000	0.19 J	4.1	180	0.66	0.27 U	57	3.1	20	23,000	5.7	120	0.054	0.25 J	48	0.13 J	0.1 J	0.11 J	40	29
UM2201	UM22	0.0 - 0.5	MG/KG	11,000	0.41	6.7	190	0.38	0.18 J	45	11	26	16,000	28	560	0.52	0.35 J	40	0.21 J	0.064 J	0.092 J	42	47
UM2301	UM23	0.0 - 0.5	MG/KG	21,000	0.58	6.6	180	0.62	0.27 J	55	13	33	24,000	26	610	1.2	0.45 J	41	0.18 J	0.11 J	0.098 J	44	68
UM2302	UM23	1.5 - 2.0	MG/KG	25,000	0.4	6.4	170	0.73	0.078 J	65	8.5	31	26,000	20	370	0.09	0.46	39	0.17 J	0.11 J	0.1 J	46	40
UM2401	UM24	0.0 - 0.5	MG/KG	13,000	0.41	5.3	140	0.48	0.18 J	50	10	26	19,000	21	450	0.28	0.43 J	51	0.14 J	0.078 J	0.093 J	40	58
UM2501	UM25	0.0 - 0.5	MG/KG	14,000	0.39	6.5	150	0.45	0.28	55	12 J	33 J	27,000	32	790	0.41	1	79 J	0.25	0.091 J	0.083 J	36	88
UM2502	UM25	1.5 - 2.0	MG/KG	8,500	1.4	5.2	170	0.57	0.85	38	9.8	19	14,000	8.8	630	0.2	0.42 J	37	0.27 J	0.03 J	0.086 J	39	430
UM2601	UM26	0.0 - 0.5	MG/KG	21,000	0.2 J	5.2	180	0.69	0.17 J	53	13	26	22,000	11	680	0.067	0.57	56	0.12 J	0.08 J	0.11 J	39	50
UM2701	UM27	0.0 - 0.5	MG/KG	15,000	0.4	5.4	160	0.48	0.28	42	17	25	16,000	36	790	0.38	0.64	40	0.14 J	0.078 J	0.085 J	37	60

Table 6: Upland Meadows Soil Detected Metals Compared to Human Health Screening Criteria
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID	Sample Location	Depth (feet bgs)	Units	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CHROMIUM	COBALT	COPPER	IRON	LEAD	MANGANESE	MERCURY	MOLYBDENUM	NICKEL	SELENIUM	SILVER	THALLIUM	VANADIUM	ZINC
Category I Criteria				20,300	109	16	2,110	29	68.1	100,000	19.9	10,900	100,000	320	212	77	1,360	60.6	1,340	1,360	2.72	1,360	81,600
Category II On-Site Management Criteria				100,000	1,090	16	100,000	290	681	100,000	199	100,000	100,000	800	2,120	275	13,600	606	13,400	13,600	27.2	13,600	100,000
Maintenance Worker Screening Criteria				100,000	2,720	16	52,600	127.75	73	100,000	34.1	100,000	100,000	320	5,300	1,920	34,000	1,180	33,500	34,000	68	34,000	100,000
Off-Site Receptors Screening Criteria				6,860,000	-	16	686,000	1,330	762	-	356	-	-	-	68,600	412,000	-	12,300	27,400,000	-	-	-	-
UM2702	UM27	1.5 - 2.0	MG/KG	19,000	0.17 J	4.1	220	0.56	0.27 U	47	15	18	18,000	9.4	960	0.064	0.42 J	37	0.13 J	0.061 J	0.098 J	38	28
UM2801-FR1	UM28-R1	0.0 - 0.5	MG/KG	12,000	0.37	7.7	280	0.52	0.23 J	40	40	25	17,000	33	2,500	0.037 U	0.53	41	0.17 J	0.067 J	0.11 J	44	45
UM2801-FR2	UM28-R2	0.0 - 0.5	MG/KG	15,000	0.4	7.2	180	0.5	0.2 J	43	14	24	17,000	34	810	0.85	0.57	37	0.16 J	0.054 J	0.093 J	41	46
UM2801-FR3	UM28-R3	0.0 - 0.5	MG/KG	15,000	0.35	7.3	180	0.49	0.15 J	44 J	11 J	21	17,000 J	21 J	780 J	0.85 J	0.35 J	32 J	0.17 J	0.061 J	0.091 J	39 J	43
UM2901	UM29	0.0 - 0.5	MG/KG	19,000	0.44	5.1	170	0.54	0.32	49	9.3	42	24,000	28	660	0.39	0.91	46	0.18 J	0.12 J	0.085 J	37	120
UM2902	UM29	1.5 - 2.0	MG/KG	23,000	0.33	5.1	180	0.7	0.14 J	58	8.4	26	23,000	16	410	1.2	0.33 J	47	0.14 J	0.074 J	0.088 J	43	51
UM3001-FR1	UM30-R1	0.0 - 0.5	MG/KG	19,000	0.22 J	5.7	170	0.6	0.21 J	51	12	25	21,000	12	690	0.12	0.31 J	57	0.095 J	0.086 J	0.1 J	40	54
UM3001-FR2	UM30-R2	0.0 - 0.5	MG/KG	20,000	0.28	6.4	170	0.58	0.32	52	12	31	22,000	16	570	0.15	0.31 J	52	0.11 J	0.094 J	0.11 J	41	75
UM3001-FR3	UM30-R3	0.0 - 0.5	MG/KG	19,000	0.26 J	6.1	210	0.58	0.28	52	18	29	22,000	15	1,200	0.1	0.47 J	69	0.12 J	0.081 J	0.12 J	42	67
UM3002-FR1	UM30-R1	1.5 - 2.0	MG/KG	20,000	0.17 J	4.6	150	0.6	0.11 J	54	11	22	20,000	9.8	580	0.068	0.29 J	39	0.13 J	0.063 J	0.099 J	40	39
UM3002-FR2	UM30-R2	1.5 - 2.0	MG/KG	20,000	0.16 J	3.5	150	0.64	0.14 J	53	10	25	19,000	11	550	0.079	0.29 J	38	0.14 J	0.09 J	0.1 J	35	45
UM3002-FR3	UM30-R3	1.5 - 2.0	MG/KG	19,000	0.13 J	4	160	0.64	0.095 J	49	12	22	17,000	9.9	560	0.1	0.25 J	33	0.13 J	0.06 J	0.089 J	34	35
UM3101	UM31	0.0 - 0.5	MG/KG	19,000	0.33	6.9	250	0.6	0.13 J	56	25	27	22,000	22	1,400	0.53	0.49	54	0.13 J	0.069 J	0.12 J	49	50
UM3201	UM32	0.0 - 0.5	MG/KG	13,000	0.32	6.3	190	0.5	0.21 J	42	12	29	16,000	25	720	0.57	0.38 J	42	0.17 J	0.077 J	0.091 J	37	49
UM3202	UM32	1.5 - 2.0	MG/KG	14,000	0.15 J	5	200	0.55	0.072 J	45	9.3	18	16,000	7.5	600	0.059	0.2 J	43	0.14 J	0.034 J	0.086 J	39	27
UM3301	UM33	0.0 - 0.5	MG/KG	16,000	0.32	6	240	0.45	0.29	51	32	46	20,000	35	1,700	1.2	0.48 J	62	0.13 J	0.1 J	0.12 J	38	73
UM3401	UM34	0.0 - 0.5	MG/KG	18,000	0.31	5.3	200	0.55	0.36	51	17	27	21,000	29	1,100	0.12	0.47 J	70	0.14 J	0.11 J	0.093 J	38	140
UM3501	UM35	0.0 - 0.5	MG/KG	17,000	0.33	4.4	160	0.49	0.24 J	44	9.2	23	16,000	31	460	0.23	0.3 J	35	0.14 J	0.075 J	0.087 J	36	57
UM3502	UM35	1.5 - 2.0	MG/KG	20,000	0.17 J	3.6	220	0.6	0.088 J	50	12	19	20,000	8.7	560	0.096	0.16 J	45	0.14 J	0.059 J	0.097 J	37	36
UM3601	UM36	0.0 - 0.5	MG/KG	12,000	0.58	11	160	0.44	0.39	37	9.9	79	21,000	55	690	2.4	0.58	37	0.35	0.26	0.11 J	34	100
UM3701	UM37	0.0 - 0.5	MG/KG	15,000	0.33	6.6	160	0.52	0.16 J	52	11	34	21,000	22	530	1.1	0.29 J	37	0.19 J	0.088 J	0.087 J	42	39
UM3702	UM37	1.5 - 2.0	MG/KG	19,000	0.22 J	6.8	180	0.74	0.064 J	57	22	22	25,000	11	790	0.16	0.32 J	42	0.24 J	0.067 J	0.1 J	50	27
UM3801	UM38	0.0 - 0.5	MG/KG	16,000	0.41	5.3	150	0.62	0.26 J	46	14	24	17,000	33	690	0.28	0.76	35	0.18 J	0.086 J	0.087 J	38	54
UM3802	UM38	1.5 - 2.0	MG/KG	21,000	0.27 J	5.4	200	0.7	0.16 J	60	31	25	19,000	21	1,100	0.045	0.61	54	0.14 J	0.075 J	0.11 J	48	49
UM3901	UM39	0.0 - 0.5	MG/KG	19,000	0.43	6.8	170	0.63	0.69	53	21	30	18,000	44	1,100	0.15	0.75	65	0.13 J	0.12 J	0.093 J	45	170
UM3902	UM39	1.5 - 2.0	MG/KG	19,000	0.27 J	6.1	490	0.83	0.28 J	52	73	26	19,000	15	5,900	0.043	1.3	170	0.12 J	0.096 J	0.14 J	51	39
UM4001	UM40	0.0 - 0.5	MG/KG	17,000	0.48	8	250	0.79	0.36	60	20	39	19,000	89	760	0.19	0.51	73	0.18 J	0.14 J	0.15 J	49	120
UM4101	UM41	0.0 - 0.5	MG/KG	15,000	4.5	51	180	0.3	6.8	53	14	170	95,000	57	350	0.59	3.1	57	0.84	3.5	0.89	43	1,100
UM4201	UM42	0.0 - 0.5	MG/KG	15,000	0.6	8.1	190	0.61	0.5	53	14	74	23,000	71	650	1.1	0.78	54	0.18 J	0.25 J	0.15 J	41	180
UM4202	UM42	1.5 - 2.0	MG/KG	17,000	0.19 J	6.3	220	0.77	0.12 J	53	13	23	16,000	16	380	0.11	0.22 J	61	0.13 J	0.07 J	0.072 J	38	46

See Table 5 for sources of maintenance worker and off-site receptor screening criteria. Category I criteria are based on the lowest of the calculated risk-based concentrations from the SCR, with the exception of arsenic, which is based on the background value. Category II criteria are based on 10 times the Category I criteria, with the exception of arsenic, which is based on the background value. In cases where 10 times the Category I criteria is greater than 100,000 mg/kg, the default value of 100,000 mg/kg is used (Tetra Tech 2013).

Chemicals that were not detected in any samples were excluded from this table. See Appendix A for full analytical results.

51 Gray highlights indicate the result exceeds either the Maintenance Worker Screening Criteria or Off-Site Receptors (Inhalation) Screening Criteria

51 Outlined boxes indicate the result exceeds the Category I Screening Criteria

-	Not applicable	J	Estimated value	U	Nondetect
MG/KG	Milligrams per kilogram	SCR	Site Characterization Report		

Tetra Tech. 2013. Site Characterization Report. Research, Education, and Support Area and Groundwater within the Richmond Field Station Site. May 28.

Table 7: Upland Meadows Soil Detected Metals Compared to Ecological Screening Criteria
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID	Sample Location	Depth (feet bgs)	Units	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CHROMIUM	COBALT	COPPER	IRON	LEAD	MANGANESE	MERCURY	MOLYBDENUM	NICKEL	SELENIUM	SILVER	THALLIUM	VANADIUM	ZINC
Plant Ecological Screening Criteria				50	5	18	500	10	32	1	13	70	-	120	220	0.3	2	38	0.52	560	1	2	160
Invertebrate Ecological Screening Criteria				-	78	60	330	40	140	0.4	-	80	-	1,700	450	0.1	-	280	4.1	-	-	-	120
Bird Ecological Screening Criteria				-	-	43	-	-	0.77		120	28	-	11	4,300	22	-	210	1.2	4.2	-	7.8	46
Mammal Ecological Screening Criteria				-	0.27	46	2,000	21	0.36	130	230	49	-	56	4,000	172	-	130	0.63	14	-	280	79
UM0101	UM01	0.0 - 0.5	MG/KG	*24,000*	0.4	5.3	170	0.67	0.15 J	***58***	9.6	22	23,000	25	***470***	**0.28**	0.52	*51*	0.16 J	0.1 J	0.092 J	*44*	47
UM0102	UM01	1.5 - 2.0	MG/KG	*26,000*	0.22 J	4.7	190	0.72	0.093 J	***64***	12	23	25,000	11	***520***	0.094	0.33 J	*56*	0.13 J	0.092 J	0.098 J	*44*	37
UM0201	UM02	0.0 - 0.5	MG/KG	*19,000*	0.53	7.6	180	0.56	0.42	***64***	*14*	34	23,000	52	***650***	**0.22**	0.59	*61*	0.24 J	0.1 J	0.12 J	*51*	100
UM0301	UM03	0.0 - 0.5	MG/KG	*24,000*	0.37	4.8	180	0.67	0.13 J	***57***	*20*	24	21,000	17	***790***	***0.31***	0.31 J	*48*	0.16 J	0.092 J	0.095 J	*44*	37
UM0401-FR1	UM04-R1	0.0 - 0.5	MG/KG	*26,000*	0.42	7.5	260	0.67	0.11 J	***63***	*18*	24	25,000	19	***830***	**0.2**	0.36 J	*50*	0.14 J	0.095 J	0.12 J	*57*	43
UM0401-FR2	UM04-R2	0.0 - 0.5	MG/KG	*20,000*	0.62	7.8	180	0.56	0.29	***54***	*17*	30	21,000	53	***840***	***0.33***	0.53	*46*	0.18 J	0.12 J	0.11 J	*49*	71
UM0401-FR3	UM04-R3	0.0 - 0.5	MG/KG	*25,000*	0.64	8	190	0.69	0.22 J	***64***	9.8	30	24,000	37	*380*	**0.23**	0.42 J	*45*	0.18 J	0.14 J	0.13 J	*55*	66
UM0402-FR1	UM04-R1	1.5 - 2.0	MG/KG	*26,000*	0.33	5.2	160	0.73	0.061 J	***61***	5.9	22	23,000	13	*260*	0.085	0.22 J	*49*	0.16 J	0.11 J	0.12 J	*48*	36
UM0402-FR2	UM04-R2	1.5 - 2.0	MG/KG	*26,000*	0.28	5.8	170	0.72	0.27 U	***65***	7.1	21	25,000	9.6	*270*	0.09	0.17 J	*55*	0.13 J	0.11 J	0.12 J	*53*	35
UM0402-FR3	UM04-R3	1.5 - 2.0	MG/KG	*27,000*	0.39	9.8	**420**	0.78	0.11 J	***70***	*63*	26	24,000	16	***2,900***	0.06	0.55	*77*	0.16 J	0.097 J	0.18 J	*70*	39
UM0501	UM05	0.0 - 0.5	MG/KG	*16,000*	0.32	5.4	150	0.49	0.11 J	***44***	12	18	17,000	19	***610***	**0.2**	0.75	29	0.17 J	0.063 J	0.082 J	*42*	33
UM0502	UM05	1.5 - 2.0	MG/KG	*22,000*	0.2 J	4.2	150	0.49	0.26 U	***51***	8.1	17	20,000	6.4	*410*	0.059	0.54	28	0.14 J	0.059 J	0.11 J	*41*	28
UM0601	UM06	0.0 - 0.5	MG/KG	*16,000*	0.43	7.3	210	0.53	0.17 J	***66***	*18*	27	28,000	25	***650***	**0.17**	0.67	*83*	0.17 J	0.12 J	0.093 J	*41*	67
UM0701	UM07	0.0 - 0.5	MG/KG	*13,000*	0.34	4.8	160	0.42	0.16 J	***39***	9.2	20	15,000	21	***590***	***0.33***	0.29 J	28	0.15 J	0.056 J	0.076 J	*37*	41
UM0702	UM07	1.5 - 2.0	MG/KG	*28,000*	0.23 J	4.9	180	0.52	0.31 U	***65***	8.9	21	27,000	9.2	*250*	0.076	0.3 J	*43*	0.14 J	0.11 J	0.13 J	*43*	39
UM0801	UM08	0.0 - 0.5	MG/KG	*21,000*	0.53	5.6	170	0.58	0.082 J	***54***	11	20	20,000	11	***530***	**0.22**	0.33 J	33 J	0.26 J	0.066 J	0.14 J	*46*	34
UM0901	UM09	0.0 - 0.5	MG/KG	*14,000*	1.9	5	150	0.46	0.23 J	***41***	10	21	15,000	35	***630***	**0.24**	0.55	26	0.25 J	0.16 J	0.11 J	*37*	53
UM1001	UM10	0.0 - 0.5	MG/KG	*12,000*	0.3	4.6	150	0.45	0.18 J	***38***	7.7	20	14,000	27	***500***	**0.12**	0.44 J	28	0.16 J	0.086 J	0.08 J	*34*	40
UM1002	UM10	1.5 - 2.0	MG/KG	*17,000*	0.2 J	4.6	130	0.54	0.28 U	***48***	7.2	16	18,000	9.9	*290*	0.038	0.32 J	30	0.17 J	0.05 J	0.093 J	*40*	26
UM1101	UM11	0.0 - 0.5	MG/KG	*16,000*	0.88	6.2	190	0.51	0.26 J	***49***	12	27	18,000	31	***650***	***0.43***	0.4 J	*39*	0.17 J	0.07 J	0.11 J	*44*	84
UM1201	UM12	0.0 - 0.5	MG/KG	*24,000*	0.69	6.5	210	0.7	0.34	***57***	10	36	22,000	47	***460***	***0.86***	0.44 J	*51*	0.18 J	0.16 J	0.11 J	*43*	75
UM1202	UM12	1.5 - 2.0	MG/KG	*23,000*	0.18 J	4.9	240	0.7	0.076 J	***52***	*16*	22	22,000	10	***650***	**0.25**	0.5 U	*53*	0.12 J	0.089 J	0.074 J	*37*	32
UM1301	UM13	0.0 - 0.5	MG/KG	*11,000*	0.39	4.6	110	0.43	0.16 J	***37***	8.2	17	12,000	25	***540***	**0.25**	0.33 J	20	0.12 J	0.081 J	0.095 J	*34*	35
UM1401	UM14	0.0 - 0.5	MG/KG	*13,000*	0.3	4.6	190	0.45	0.13 J	***41***	11	19	15,000	16	***700***	**0.23**	0.32 J	34	0.15 J	0.049 J	0.085 J	*37*	35
UM1402	UM14	1.5 - 2.0	MG/KG	*14,000*	0.22 J	4.3	230	0.5	0.09 J	***42***	*16*	18	16,000	7.5	***1,000***	0.063	0.27 J	*39*	0.18 J	0.037 J	0.095 J	*38*	27
UM1501	UM15	0.0 - 0.5	MG/KG	*23,000*	0.58	6.2	170	0.62	0.29	***57***	*15*	29	23,000	33	***720***	***0.58***	0.46	*39*	0.19 J	0.11 J	0.11 J	*46*	83
UM1601	UM16	0.0 - 0.5	MG/KG	*23,000*	0.39	5.6	240	0.73	0.091 J	***58***	*18*	20	23,000	16	***640***	**0.15**	0.3 J	*50*	0.18 J	0.11 J	0.12 J	*46*	35
UM1602	UM16	1.5 - 2.0	MG/KG	*19,000*	0.59	6.3	180	0.52	0.19 J	***48***	*15*	25	19,000	42	***620***	***0.53***	0.45 J	38	0.19 J	0.11 J	0.1 J	*42*	49
UM1701	UM17	0.0 - 0.5	MG/KG	*15,000*	0.27	5.2	170	0.45	0.18 J	***56***	*15*	21	20,000	23	***630***	**0.12**	0.79	*52*	0.19 J	0.08 J	0.089 J	*38*	57
UM1801	UM18	0.0 - 0.5	MG/KG	*14,000*	0.67	4.7	160	0.44	0.19 J	***38***	8.7 J	22	14,000	24 J	***600***	***0.71***	0.41 J	25 J	0.19 J	0.1 J	0.1 J	*32 J*	45
UM1802	UM18	1.5 - 2.0	MG/KG	*19,000*	0.7	6.2	250	0.59	0.09 J	***46***	*26*	21	21,000	14	***1,300***	**0.13**	0.37 J	35	0.2 J	0.06 J	0.12 J	*44*	30
UM1901-FR1	UM19-R1	0.0 - 0.5	MG/KG	*15,000*	0.27 J	6.5	180	0.38	0.28	***160***	*23*	28	23,000	25	***760***	***0.41***	0.41 J	***280***	0.13 J	0.071 J	0.084 J	*40*	79
UM1901-FR2	UM19-R2	0.0 - 0.5	MG/KG	*17,000*	0.61	7.6	170	0.64	0.25 J	***59***	*14*	36	23,000	35	***550***	***0.43***	0.5	*55*	0.21 J	0.12 J	0.1 J	*47*	72
UM1901-FR3	UM19-R3	0.0 - 0.5	MG/KG	*20,000*	0.51	6.8	170	0.59	0.23 J	***54***	13	29	21,000	34	***640***	***0.49***	0.38 J	*52*	0.12 J	0.084 J	0.1 J	*42*	67
UM2001	UM20	0.0 - 0.5	MG/KG	*22,000*	0.48	6.3	210	0.62	0.17 J	***59***	*22*	26	21,000	26	***860***	***0.5***	0.61	36	0.2 J	0.17 J	0.12 J	*47*	48
UM2101	UM21	0.0 - 0.5	MG/KG	*18,000*	0.54	7.2	150	0.56	0.21 J	***56***	6	24	21,000	40	*340*	***0.59***	0.58	35	0.14 J	0.096 J	0.096 J	*48*	49
UM2102	UM21	1.5 - 2.0	MG/KG	*25,000*	0.19 J	4.1	180	0.66	0.27 U	***57***	3.1	20	23,000	5.7	120	0.054	0.25 J	*48*	0.13 J	0.1 J	0.11 J	*40*	29
UM2201	UM22	0.0 - 0.5	MG/KG	*11,000*	0.41	6.7	190	0.38	0.18 J	***45***	11	26	16,000	28	***560***	***0.52***	0.35 J	*40*	0.21 J	0.064 J	0.092 J	*42*	47
UM2301	UM23	0.0 - 0.5	MG/KG	*21,000*	0.58	6.6	180	0.62	0.27 J	***55***	13	33	24,000	26	***610***	***1.2***	0.45 J	*41*	0.18 J	0.11 J	0.098 J	*44*	68
UM2302	UM23	1.5 - 2.0	MG/KG	*25,000*	0.4	6.4	170	0.73	0.078 J	***65***	8.5	31	26,000	20	*370*	0.09	0.46	*39*	0.17 J	0.11 J	0.1 J	*46*	40
UM2401	UM24	0.0 - 0.5	MG/KG	*13,000*	0.41	5.3	140	0.48	0.18 J	***50***	10	26	19,000	21	*450*	**0.28**	0.43 J	*51*	0.14 J	0.078 J	0.093 J	*40*	58
UM2501	UM25	0.0 - 0.5	MG/KG	*14,000*	0.39	6.5	150	0.45	0.28	***55***	12 J	33 J	27,000	32	***790***	***0.41***	1	*79 J*	0.25	0.091 J	0.083 J	*36*	88
UM2502	UM25	1.5 - 2.0	MG/KG	*8,500*	1.4	5.2	170	0.57	0.85	***38***	9.8	19	14,000	8.8	***630***	**0.2**	0.42 J	37	0.27 J	0.03 J	0.086 J	*39*	***430***
UM2601	UM26	0.0 - 0.5	MG/KG	*21,000*	0.2 J	5.2	180	0.69	0.17 J	***53***	13	26	22,000	11	***680***	0.067	0.57	*56*	0.12 J	0.08 J	0.11 J	*39*	50
UM2701	UM27	0.0 - 0.5	MG/KG	*15,000*	0.4	5.4	160	0.48	0.28	***42***	*17*	25	16,000	36	***790***	***0.38***	0.64	*40*	0.14 J	0.078 J	0.085 J	*37*	60

Table 7: Upland Meadows Soil Detected Metals Compared to Ecological Screening Criteria
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID	Sample Location	Depth (feet bgs)	Units	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CHROMIUM	COBALT	COPPER	IRON	LEAD	MANGANESE	MERCURY	MOLYBDENUM	NICKEL	SELENIUM	SILVER	THALLIUM	VANADIUM	ZINC
Plant Ecological Screening Criteria				50	5	18	500	10	32	1	13	70	-	120	220	0.3	2	38	0.52	560	1	2	160
Invertebrate Ecological Screening Criteria				-	78	60	330	40	140	0.4	-	80	-	1,700	450	0.1	-	280	4.1	-	-	-	120
Bird Ecological Screening Criteria				-	-	43	-	-	0.77		120	28	-	11	4,300	22	-	210	1.2	4.2	-	7.8	46
Mammal Ecological Screening Criteria				-	0.27	46	2,000	21	0.36	130	230	49	-	56	4,000	172	-	130	0.63	14	-	280	79
UM2702	UM27	1.5 - 2.0	MG/KG	*19,000*	0.17 J	4.1	220	0.56	0.27 U	***47***	*15*	18	18,000	9.4	***960***	0.064	0.42 J	37	0.13 J	0.061 J	0.098 J	*38*	28
UM2801-FR1	UM28-R1	0.0 - 0.5	MG/KG	*12,000*	0.37	7.7	280	0.52	0.23 J	***40***	*40*	25	17,000	33	***2,500***	0.037 U	0.53	*41*	0.17 J	0.067 J	0.11 J	*44*	45
UM2801-FR2	UM28-R2	0.0 - 0.5	MG/KG	*15,000*	0.4	7.2	180	0.5	0.2 J	***43***	*14*	24	17,000	34	***810***	***0.85***	0.57	37	0.16 J	0.054 J	0.093 J	*41*	46
UM2801-FR3	UM28-R3	0.0 - 0.5	MG/KG	*15,000*	0.35	7.3	180	0.49	0.15 J	***44 J***	11 J	21	17,000 J	21 J	***780 J***	***0.85 J***	0.35 J	32 J	0.17 J	0.061 J	0.091 J	*39 J*	43
UM2901	UM29	0.0 - 0.5	MG/KG	*19,000*	0.44	5.1	170	0.54	0.32	***49***	9.3	42	24,000	28	***660***	***0.39***	0.91	*46*	0.18 J	0.12 J	0.085 J	*37*	120
UM2902	UM29	1.5 - 2.0	MG/KG	*23,000*	0.33	5.1	180	0.7	0.14 J	***58***	8.4	26	23,000	16	*410*	***1.2***	0.33 J	*47*	0.14 J	0.074 J	0.088 J	*43*	51
UM3001-FR1	UM30-R1	0.0 - 0.5	MG/KG	*19,000*	0.22 J	5.7	170	0.6	0.21 J	***51***	12	25	21,000	12	***690***	**0.12**	0.31 J	*57*	0.095 J	0.086 J	0.1 J	*40*	54
UM3001-FR2	UM30-R2	0.0 - 0.5	MG/KG	*20,000*	0.28	6.4	170	0.58	0.32	***52***	12	31	22,000	16	***570***	**0.15**	0.31 J	*52*	0.11 J	0.094 J	0.11 J	*41*	75
UM3001-FR3	UM30-R3	0.0 - 0.5	MG/KG	*19,000*	0.26 J	6.1	210	0.58	0.28	***52***	*18*	29	22,000	15	***1,200***	0.1	0.47 J	*69*	0.12 J	0.081 J	0.12 J	*42*	67
UM3002-FR1	UM30-R1	1.5 - 2.0	MG/KG	*20,000*	0.17 J	4.6	150	0.6	0.11 J	***54***	11	22	20,000	9.8	***580***	0.068	0.29 J	*39*	0.13 J	0.063 J	0.099 J	*40*	39
UM3002-FR2	UM30-R2	1.5 - 2.0	MG/KG	*20,000*	0.16 J	3.5	150	0.64	0.14 J	***53***	10	25	19,000	11	***550***	0.079	0.29 J	38	0.14 J	0.09 J	0.1 J	*35*	45
UM3002-FR3	UM30-R3	1.5 - 2.0	MG/KG	*19,000*	0.13 J	4	160	0.64	0.095 J	***49***	12	22	17,000	9.9	***560***	0.1	0.25 J	33	0.13 J	0.06 J	0.089 J	*34*	35
UM3101	UM31	0.0 - 0.5	MG/KG	*19,000*	0.33	6.9	250	0.6	0.13 J	***56***	*25*	27	22,000	22	***1,400***	***0.53***	0.49	*54*	0.13 J	0.069 J	0.12 J	*49*	50
UM3201	UM32	0.0 - 0.5	MG/KG	*13,000*	0.32	6.3	190	0.5	0.21 J	***42***	12	29	16,000	25	***720***	***0.57***	0.38 J	*42*	0.17 J	0.077 J	0.091 J	*37*	49
UM3202	UM32	1.5 - 2.0	MG/KG	*14,000*	0.15 J	5	200	0.55	0.072 J	***45***	9.3	18	16,000	7.5	***600***	0.059	0.2 J	*43*	0.14 J	0.034 J	0.086 J	*39*	27
UM3301	UM33	0.0 - 0.5	MG/KG	*16,000*	0.32	6	240	0.45	0.29	***51***	*32*	46	20,000	35	***1,700***	***1.2***	0.48 J	*62*	0.13 J	0.1 J	0.12 J	*38*	73
UM3401	UM34	0.0 - 0.5	MG/KG	*18,000*	0.31	5.3	200	0.55	0.36	***51***	*17*	27	21,000	29	***1,100***	**0.12**	0.47 J	*70*	0.14 J	0.11 J	0.093 J	*38*	**140**
UM3501	UM35	0.0 - 0.5	MG/KG	*17,000*	0.33	4.4	160	0.49	0.24 J	***44***	9.2	23	16,000	31	***460***	**0.23**	0.3 J	35	0.14 J	0.075 J	0.087 J	*36*	57
UM3502	UM35	1.5 - 2.0	MG/KG	*20,000*	0.17 J	3.6	220	0.6	0.088 J	***50***	12	19	20,000	8.7	***560***	0.096	0.16 J	*45*	0.14 J	0.059 J	0.097 J	*37*	36
UM3601	UM36	0.0 - 0.5	MG/KG	*12,000*	0.58	11	160	0.44	0.39	***37***	9.9	79	21,000	55	***690***	***2.4***	0.58	37	0.35	0.26	0.11 J	*34*	100
UM3701	UM37	0.0 - 0.5	MG/KG	*15,000*	0.33	6.6	160	0.52	0.16 J	***52***	11	34	21,000	22	***530***	***1.1***	0.29 J	37	0.19 J	0.088 J	0.087 J	*42*	39
UM3702	UM37	1.5 - 2.0	MG/KG	*19,000*	0.22 J	6.8	180	0.74	0.064 J	***57***	*22*	22	25,000	11	***790***	**0.16**	0.32 J	*42*	0.24 J	0.067 J	0.1 J	*50*	27
UM3801	UM38	0.0 - 0.5	MG/KG	*16,000*	0.41	5.3	150	0.62	0.26 J	***46***	*14*	24	17,000	33	***690***	**0.28**	0.76	35	0.18 J	0.086 J	0.087 J	*38*	54
UM3802	UM38	1.5 - 2.0	MG/KG	*21,000*	0.27 J	5.4	200	0.7	0.16 J	***60***	*31*	25	19,000	21	***1,100***	0.045	0.61	*54*	0.14 J	0.075 J	0.11 J	*48*	49
UM3901	UM39	0.0 - 0.5	MG/KG	*19,000*	0.43	6.8	170	0.63	0.69	***53***	*21*	30	18,000	44	***1,100***	**0.15**	0.75	*65*	0.13 J	0.12 J	0.093 J	*45*	***170***
UM3902	UM39	1.5 - 2.0	MG/KG	*19,000*	0.27 J	6.1	**490**	0.83	0.28 J	***52***	*73*	26	19,000	15	***5,900***	0.043	1.3	*170*	0.12 J	0.096 J	0.14 J	*51*	39
UM4001	UM40	0.0 - 0.5	MG/KG	*17,000*	0.48	8	250	0.79	0.36	***60***	*20*	39	19,000	89	***760***	**0.19**	0.51	*73*	0.18 J	0.14 J	0.15 J	*49*	120
UM4101	UM41	0.0 - 0.5	MG/KG	*15,000*	4.5	*51*	180	0.3	6.8	***53***	*14*	***170***	95,000	57	*350*	***0.59***	*3.1*	*57*	*0.84*	3.5	0.89	*43*	***1,100***
UM4201	UM42	0.0 - 0.5	MG/KG	*15,000*	0.6	8.1	190	0.61	0.5	***53***	*14*	*74*	23,000	71	***650***	***1.1***	0.78	*54*	0.18 J	0.25 J	0.15 J	*41*	***180***
UM4202	UM42	1.5 - 2.0	MG/KG	*17,000*	0.19 J	6.3	220	0.77	0.12 J	***53***	13	23	16,000	16	*380*	**0.11**	0.22 J	*61*	0.13 J	0.07 J	0.072 J	*38*	46

See Table 5 for sources of screening criteria.
Chemicals that were not detected in any samples were excluded from this table. See Appendix A for full analytical results.

51	Italics indicate the result exceeds the plant criteria.
51	Bold italics indicate the result exceeds the invertebrate criteria.
51	Outlined boxes indicate the result exceeds the the bird criteria.
51	Gray highlights indicate the result exceeds mammal criteria.

-	Not applicable
MG/KG	Milligrams per kilogram
J	Estimated value
U	Nondetect

Table 8: Upland Meadows Soil Detected PAH Compared to Human Health and Ecological Screening Criteria
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID	Sample Location	Depth (feet bgs)	Units	1-METHYLNAPHTHALENE	2-METHYLNAPHTHALENE	ACENAPHTHENE	ACENAPHTHYLENE	ANTHRACENE	BENZO(A)ANTHRACENE	BENZO(A)PYRENE	BENZO(B)FLUORANTHENE	BENZO(G,H,I)PERYLENE	BENZO(K)FLUORANTHENE	CHRYSENE	DIBENZ(A,H)ANTHRACENE	FLUORANTHENE	FLUORENE	INDENO(1,2,3-CD)PYRENE	NAPHTHALENE	PHENANTHRENE	PYRENE	BAP (EQ)
Category I Criteria				36.4	403	6,050	6,050	30,200	0.88	0.145	0.88	3,020	0.88	8.8	0.145	4,030	4,030	0.88	3.57	4,030	3,020	0.4
Category II On-Site Management Criteria				364	4,030	60,500	60,500	100,000	8.8	1.45	8.8	30,200	8.8	88	1.45	40,300	40,300	8.8	35.7	40,300	30,200	1.45
Maintenance Worker Screening Criteria				-	10,100	100,000	100,000	100,000	5.87	0.963	5.87	75,600	5.87	58.7	0.963	100,000	100,000	5.87	450	100,000	75,600	0.4
Off-Site Receptors Screening Criteria				-	-	-	-	-	11,500	1,150	11,500	-	11,500	115,000	2,670	-	-	11,500	3.57	-	-	0.4
Plant Ecological Screening Criteria				-	20	20	20	20	-	-	-	-	-	-	-	-	20	-	-	20	-	-
Invertebrate Ecological Screening Criteria				-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-	-	-
UM0101	UM01	0.0 - 0.5	MG/KG	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0046 J	0.0065	0.011	0.011	0.0051 J	0.0093	0.0019 J	0.016	0.0055 U	0.0058	0.0055 U	0.0058	0.011	0.0106003
UM0102	UM01	1.5 - 2.0	MG/KG	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0 U
UM0201	UM02	0.0 - 0.5	MG/KG	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0.14 U	0 U
UM0301	UM03	0.0 - 0.5	MG/KG	0.011 UJ	0.011 UJ	0.011 UJ	0.011 U	0.011 U	0.0026 J	0.0034 J	0.0048 J	0.0063 J	0.003 J	0.0055 J	0.011 U	0.0098 J	0.011 U	0.0036 J	0.011 U	0.0039 J	0.0057 J	0.0045355
UM0401-FR1	UM04-R1	0.0 - 0.5	MG/KG	0.0055 UJ	0.0055 UJ	0.0055 UJ	0.0055 U	0.0055 U	0.0031 J	0.0041 J	0.0059	0.0086	0.0043 J	0.0062	0.0055 U	0.013	0.0055 U	0.0041 J	0.0055 U	0.0045 J	0.0073	0.0054592
UM0401-FR2	UM04-R2	0.0 - 0.5	MG/KG	0.0054 UJ	0.0054 UJ	0.0054 UJ	0.0054 U	0.0016 J	0.011	0.014	0.03	0.021	0.0071	0.022	0.0038 J	0.031	0.0054 U	0.01	0.0054 U	0.015	0.027	0.022993
UM0401-FR3	UM04-R3	0.0 - 0.5	MG/KG	0.0055 UJ	0.0055 UJ	0.0055 UJ	0.0055 U	0.0055 U	0.0055	0.0066	0.012	0.013	0.007	0.014	0.0019 J	0.023	0.0055 U	0.0062	0.0055 U	0.0097	0.013	0.010954
UM0402-FR1	UM04-R1	1.5 - 2.0	MG/KG	0.0056 UJ	0.0056 UJ	0.0056 UJ	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0013 J	0.0016 J	0.0056 U	0.0012 J	0.0056 U	0.0015 J	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0015 J	0.0001312
UM0402-FR2	UM04-R2	1.5 - 2.0	MG/KG	0.0055 UJ	0.0055 UJ	0.0055 UJ	0.0055 U	0.0055 U	0.0015 J	0.002 J	0.0034 J	0.0036 J	0.0055 U	0.0027 J	0.0055 U	0.0038 J	0.0055 U	0.0019 J	0.0055 U	0.0019 J	0.0037 J	0.0026827
UM0402-FR3	UM04-R3	1.5 - 2.0	MG/KG	0.0055 UJ	0.0055 UJ	0.0055 UJ	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0019 J	0.0055 U	0.0055 U	0.0017 J	0.0055 U	0.0024 J	0.0055 U	0.0055 U	0.0055 U	0.0016 J	0.002 J	0.0001917
UM0501	UM05	0.0 - 0.5	MG/KG	0.0055 UJ	0.0055 UJ	0.0055 UJ	0.0055 U	0.0055 U	0.0033 J	0.004 J	0.0079	0.0046 J	0.0022 J	0.0055	0.0055 U	0.0085	0.0055 U	0.0031 J	0.0055 U	0.0051 J	0.0075	0.0054575
UM0502	UM05	1.5 - 2.0	MG/KG	0.0057 UJ	0.0057 UJ	0.0057 UJ	0.0057 U	0.0057 U	0.0057 U	0.0057 U	0.0013 J	0.0057 U	0.0057 U	0.0057 U	0.0057 U	0.0015 J	0.0057 U	0.0057 U	0.0057 U	0.0057 U	0.0014 J	0.00013
UM0601	UM06	0.0 - 0.5	MG/KG	0.13 UJ	0.13 UJ	0.13 UJ	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0 U
UM0701	UM07	0.0 - 0.5	MG/KG	0.0055 UJ	0.0055 UJ	0.0055 UJ	0.0055 U	0.0055 U	0.005 J	0.0068	0.011	0.01	0.0069	0.0099	0.0024 J	0.017	0.0055 U	0.0066	0.0055 U	0.007	0.012	0.0115389
UM0702	UM07	1.5 - 2.0	MG/KG	0.0062 UJ	0.0062 UJ	0.0062 UJ	0.0062 U	0.0062 U	0.0062 U	0.0062 U	0.0062 U	0.0062 U	0.0062 U	0.0062 U	0.0062 U	0.0062 U	0.0062 U	0.0062 U	0.0062 U	0.0062 U	0.0062 U	0 U
UM0801	UM08	0.0 - 0.5	MG/KG	0.0053 UJ	0.0053 UJ	0.0053 UJ	0.0053 U	0.0053 U	0.0013 J	0.0014 J	0.0022 J	0.0018 J	0.0053 U	0.0018 J	0.0053 U	0.0027 J	0.0053 U	0.0053 U	0.0053 U	0.0012 J	0.0025 J	0.0017518
UM0901	UM09	0.0 - 0.5	MG/KG	0.011 UJ	0.011 UJ	0.011 UJ	0.011 U	0.011 U	0.011 J	0.012	0.022	0.0081 J	0.0065 J	0.016	0.011 U	0.025	0.011 U	0.0051 J	0.011 U	0.015	0.023	0.015891
UM1001	UM10	0.0 - 0.5	MG/KG	0.0054 UJ	0.0054 UJ	0.0054 UJ	0.0054 U	0.0054 U	0.0082	0.013	0.016	0.021	0.016	0.016	0.003 J	0.028	0.0054 U	0.0092	0.0054 U	0.0098	0.02	0.019516
UM1002	UM10	1.5 - 2.0	MG/KG	0.0056 UJ	0.0056 UJ	0.0056 UJ	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0 U
UM1101	UM11	0.0 - 0.5	MG/KG	0.0054 UJ	0.0054 UJ	0.0054 UJ	0.0054 U	0.0054 U	0.0035 J	0.0045 J	0.0094	0.0039 J	0.0024 J	0.0082	0.0054 U	0.012	0.0054 U	0.0029 J	0.0054 U	0.0077	0.01	0.0061122
UM1201	UM12	0.0 - 0.5	MG/KG	0.0056 UJ	0.0056 UJ	0.0045 J	0.0056 U	0.007	0.031	0.034	0.097	0.035	0.017	0.052	0.0048 J	0.11 J	0.0056 U	0.017	0.0014 J	0.058	0.1	0.053522
UM1202	UM12	1.5 - 2.0	MG/KG	0.0055 UJ	0.0055 UJ	0.0016 J	0.0055 U	0.0018 J	0.0068	0.006	0.0076	0.0044 J	0.0035 J	0.0083	0.0055 U	0.019	0.0055 U	0.0033 J	0.0055 U	0.014	0.017	0.0078133
UM1301	UM13	0.0 - 0.5	MG/KG	0.0052 UJ	0.0052 UJ	0.0052 UJ	0.0052 U	0.0052 U	0.0038 J	0.0039 J	0.0085	0.0031 J	0.0022 J	0.0066	0.0052 U	0.01	0.0052 U	0.0022 J	0.0052 U	0.0058	0.0087	0.0053786
UM1401	UM14	0.0 - 0.5	MG/KG	0.0053 UJ	0.0053 UJ	0.0053 UJ	0.0053 U	0.0053 U	0.0035 J	0.0046 J	0.0095	0.0028 J	0.0028 J	0.0067	0.0053 U	0.011	0.0053 U	0.0021 J	0.0053 U	0.0048 J	0.0086	0.0061447
UM1402	UM14	1.5 - 2.0	MG/KG	0.0054 UJ	0.0054 UJ	0.0054 UJ	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0019 J	0.0054 U	0.0054 U	0.0021 J	0.0054 U	0.0017 J	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0011 J	0.0001921
UM1501	UM15	0.0 - 0.5	MG/KG	0.0057 UJ	0.0057 UJ	0.0057 UJ	0.0057 U	0.0057 U	0.0048 J	0.0054 J	0.012	0.0044 J	0.0036 J	0.008	0.0057 U	0.014	0.0057 U	0.0033 J	0.0057 U	0.0087	0.012	0.007454
UM1601	UM16	0.0 - 0.5	MG/KG	0.0056 UJ	0.0056 UJ	0.0056 UJ	0.0056 U	0.0056 U	0.0056 U	0.0012 J	0.0025 J	0.0015 J	0.0056 U	0.0022 J	0.0056 U	0.0037 J	0.0056 U	0.0056 U	0.0056 U	0.0021 J	0.0027 J	0.0014522
UM1602	UM16	1.5 - 2.0	MG/KG	0.0056 UJ	0.0056 UJ	0.0056 UJ	0.0056 U	0.0018 J	0.0087	0.011	0.02	0.0062	0.0076	0.021	0.0014 J	0.035	0.0056 U	0.0047 J	0.0012 J	0.019	0.024	0.015837
UM1701	UM17	0.0 - 0.5	MG/KG	0.053 UJ	0.053 UJ	0.053 UJ	0.053 U	0.053 U	0.053 U	0.053 U	0.053 U	0.022 J	0.053 U	0.053 U	0.053 U	0.053 U	0.053 U	0.053 U	0.053 U	0.013 J	0.012 J	0 U
UM1801	UM18	0.0 - 0.5	MG/KG	0.0054 UJ	0.0054 UJ	0.0054 UJ	0.0054 U	0.0054 U	0.0065	0.0076	0.032	0.012	0.0047 J	0.014	0.0054 U	0.019	0.0054 U	0.005 J	0.0054 U	0.01	0.019	0.012011

Table 8: Upland Meadows Soil Detected PAH Compared to Human Health and Ecological Screening Criteria
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID	Sample Location	Depth (feet bgs)	Units	1-METHYLNAPHTHALENE	2-METHYLNAPHTHALENE	ACENAPHTHENE	ACENAPHTHYLENE	ANTHRACENE	BENZO(A)ANTHRACENE	BENZO(A)PYRENE	BENZO(B)FLUORANTHENE	BENZO(G,H,I)PERYLENE	BENZO(K)FLUORANTHENE	CHRYSENE	DIBENZ(A,H)ANTHRACENE	FLUORANTHENE	FLUORENE	INDENO(1,2,3-CD)PYRENE	NAPHTHALENE	PHENANTHRENE	PYRENE	BAP (EQ)
Category I Criteria				36.4	403	6,050	6,050	30,200	0.88	0.145	0.88	3,020	0.88	8.8	0.145	4,030	4,030	0.88	3.57	4,030	3,020	0.4
Category II On-Site Management Criteria				364	4,030	60,500	60,500	100,000	8.8	1.45	8.8	30,200	8.8	88	1.45	40,300	40,300	8.8	35.7	40,300	30,200	1.45
Maintenance Worker Screening Criteria				-	10,100	100,000	100,000	100,000	5.87	0.963	5.87	75,600	5.87	58.7	0.963	100,000	100,000	5.87	450	100,000	75,600	0.4
Off-Site Receptors Screening Criteria				-	-	-	-	-	11,500	1,150	11,500	-	11,500	115,000	2,670	-	-	11,500	3.57	-	-	0.4
Plant Ecological Screening Criteria				-	20	20	20	20	-	-	-	-	-	-	-	-	20	-	-	20	-	-
Invertebrate Ecological Screening Criteria				-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-	-	-
UM1802	UM18	1.5 - 2.0	MG/KG	0.0055 UJ	0.0055 UJ	0.0055 UJ	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0029 J	0.0014 J	0.0055 U	0.0022 J	0.0055 U	0.003 J	0.0055 U	0.0055 U	0.0055 U	0.0015 J	0.0024 J	0.0002922
UM1901-FR1	UM19-R1	0.0 - 0.5	MG/KG	0.0056 UJ	0.0056 UJ	0.0056 UJ	0.0056 U	0.0056 U	0.0067	0.0088	0.017	0.0061	0.0052 J	0.012	0.0015 J	0.019	0.0056 U	0.0048 J	0.0056 U	0.011	0.016	0.013214
UM1901-FR2	UM19-R2	0.0 - 0.5	MG/KG	0.0056 UJ	0.0014 J	0.0056 UJ	0.0021 J	0.0091	0.046	0.041	0.05	0.011	0.017	0.044	0.0034 J	0.087	0.0018 J	0.011	0.0014 J	0.034	0.08	0.055314
UM1901-FR3	UM19-R3	0.0 - 0.5	MG/KG	0.0015 J	0.0019 J	0.0018 J	0.0056 U	0.0026 J	0.014	0.017	0.027	0.013	0.013	0.022	0.0034 J	0.047	0.0018 J	0.01	0.0013 J	0.021	0.031	0.025652
UM2001	UM20	0.0 - 0.5	MG/KG	0.0054 UJ	0.0054 UJ	0.0012 J	0.0054 U	0.0016 J	0.0065	0.008	0.02	0.011	0.0037 J	0.014	0.002 J	0.026	0.0054 U	0.0065	0.0054 U	0.016	0.022	0.013351
UM2101	UM21	0.0 - 0.5	MG/KG	0.0055 UJ	0.0055 UJ	0.0055 UJ	0.0055 U	0.0015 J	0.0075	0.0095	0.02	0.017	0.0054 J	0.018	0.0022 J	0.032	0.0055 U	0.0078	0.0015 J	0.016	0.025	0.015302
UM2102	UM21	1.5 - 2.0	MG/KG	0.0054 UJ	0.0054 UJ	0.0054 UJ	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0015 J	0.0019 J	0.0054 U	0.0012 J	0.0054 U	0.0016 J	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0016 J	0.0001512
UM2201	UM22	0.0 - 0.5	MG/KG	0.0054 UJ	0.0054 UJ	0.0054 UJ	0.0054 U	0.0054 U	0.0027 J	0.0036 J	0.0072	0.0037 J	0.0021 J	0.0061	0.0054 U	0.0086	0.0054 U	0.0026 J	0.0054 U	0.0048 J	0.0073	0.0048771
UM2301	UM23	0.0 - 0.5	MG/KG	0.017 UJ	0.017 UJ	0.017 UJ	0.017 U	0.017 U	0.0056 J	0.0074 J	0.016 J	0.0057 J	0.0039 J	0.011 J	0.017 U	0.015 J	0.017 U	0.0039 J	0.017 U	0.0079 J	0.013 J	0.01
UM2302	UM23	1.5 - 2.0	MG/KG	0.0057 UJ	0.0057 UJ	0.0057 UJ	0.0057 U	0.0057 U	0.0057 U	0.0057 U	0.0016 J	0.0057 U	0.0057 U	0.0012 J	0.0057 U	0.0021 J	0.0057 U	0.0057 U	0.0057 U	0.0013 J	0.002 J	0.0001612
UM2401	UM24	0.0 - 0.5	MG/KG	0.0024 J	0.0038 J	0.011 UJ	0.0032 J	0.005 J	0.0097 J	0.014	0.049	0.023	0.011 J	0.037	0.0052 J	0.06	0.011 U	0.013	0.011 U	0.027	0.042	0.026517
UM2501	UM25	0.0 - 0.5	MG/KG	0.27 UJ	0.27 UJ	0.27 UJ	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0.27 U	0 U
UM2502	UM25	1.5 - 2.0	MG/KG	0.0054 UJ	0.0054 UJ	0.0054 UJ	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0017 J	0.0014 J	0.0054 U	0.0017 J	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0001717
UM2601	UM26	0.0 - 0.5	MG/KG	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0012 J	0.0015 J	0.0021 J	0.0039 J	0.0016 J	0.0019 J	0.0055 U	0.0033 J	0.0055 U	0.0019 J	0.0055 U	0.0014 J	0.0022 J	0.0020379
UM2701	UM27	0.0 - 0.5	MG/KG	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0073	0.011	0.02	0.011	0.0093	0.017	0.0024 J	0.03	0.0053 U	0.0085	0.0053 U	0.0097	0.018	0.01709
UM2702	UM27	1.5 - 2.0	MG/KG	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0016 J	0.0054 U	0.0054 U	0.0054 U	0.0015 J	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0 U
UM2801-FR1	UM28-R1	0.0 - 0.5	MG/KG	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0019 J	0.0055 U	0.013	0.032	0.051	0.0076	0.018	0.0055 U	0.021	0.0055 U	0.0055 U	0.0055 U	0.0098	0.019	0.016294
UM2801-FR2	UM28-R2	0.0 - 0.5	MG/KG	0.011 U	0.011 U	0.011 U	0.011 U	0.0023 J	0.011 U	0.012	0.023	0.035	0.0052 J	0.02	0.011 U	0.027	0.011 U	0.011 U	0.011 U	0.013	0.022	0.014372
UM2801-FR3	UM28-R3	0.0 - 0.5	MG/KG	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0012 J	0.0056 U	0.0085	0.023	0.037	0.0048 J	0.014	0.0056 U	0.018	0.0056 U	0.0068	0.0056 U	0.0083	0.017	0.011542
UM2901	UM29	0.0 - 0.5	MG/KG	0.029 UJ	0.029 UJ	0.029 UJ	0.029 U	0.022 J	0.092	0.16	0.47	0.23	0.091	0.21	0.058	0.21	0.029 U	0.17	0.029 U	0.056	0.21	0.29232
UM2902	UM29	1.5 - 2.0	MG/KG	0.0058 UJ	0.0058 UJ	0.0058 UJ	0.0058 U	0.0019 J	0.0061	0.0083	0.019	0.014	0.0049 J	0.012	0.0027 J	0.013	0.0058 U	0.0091	0.0058 U	0.0065	0.014	0.014481
UM3001-FR1	UM30-R1	0.0 - 0.5	MG/KG	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0024 J	0.0028 J	0.0042 J	0.0047 J	0.0026 J	0.0043 J	0.0054 U	0.0069	0.0054 U	0.0024 J	0.0054 U	0.0026 J	0.0049 J	0.0037303
UM3001-FR2	UM30-R2	0.0 - 0.5	MG/KG	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.007	0.0075	0.012	0.0049 J	0.0041 J	0.0098	0.0011 J	0.014	0.0054 U	0.0036 J	0.0054 U	0.0049 J	0.011	0.0109108
UM3001-FR3	UM30-R3	0.0 - 0.5	MG/KG	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0019 J	0.0024 J	0.0049 J	0.0026 J	0.0016 J	0.0035 J	0.0054 U	0.005 J	0.0054 U	0.0015 J	0.0054 U	0.0028 J	0.0041 J	0.0032495
UM3002-FR1	UM30-R1	1.5 - 2.0	MG/KG	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0 U
UM3002-FR2	UM30-R2	1.5 - 2.0	MG/KG	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0015 J	0.0054 U	0.0054 U	0.0012 J	0.0054 U	0.0015 J	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0012 J	0.0001512
UM3002-FR3	UM30-R3	1.5 - 2.0	MG/KG	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0054 U	0.0011 J	0.0023 J	0.0015 J	0.0054 U	0.0019 J	0.0054 U	0.0037 J	0.0054 U	0.0054 U	0.0054 U	0.0019 J	0.0024 J	0.0013319
UM3101	UM31	0.0 - 0.5	MG/KG	0.0053 U	0.0013 J	0.0053 U	0.0053 U	0.0053 U	0.0033 J	0.0033 J	0.0056	0.0027 J	0.0016 J	0.0044 J	0.0053 U	0.0075	0.0053 U	0.0018 J	0.0053 U	0.0032 J	0.006	0.0043904
UM3201	UM32	0.0 - 0.5	MG/KG	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0042 J	0.0051 J	0.0089	0.0073	0.0062	0.0095	0.0014 J	0.016	0.0053 U	0.0037 J	0.0053 U	0.007	0.0097	0.0082515
UM3202	UM32	1.5 - 2.0	MG/KG	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0.0053 U	0 U

Table 8: Upland Meadows Soil Detected PAH Compared to Human Health and Ecological Screening Criteria
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID	Sample Location	Depth (feet bgs)	Units	1-METHYLNAPHTHALENE	2-METHYLNAPHTHALENE	ACENAPHTHENE	ACENAPHTHYLENE	ANTHRACENE	BENZO(A)ANTHRACENE	BENZO(A)PYRENE	BENZO(B)FLUORANTHENE	BENZO(G,H,I)PERYLENE	BENZO(K)FLUORANTHENE	CHRYSENE	DIBENZ(A,H)ANTHRACENE	FLUORANTHENE	FLUORENE	INDENO(1,2,3-CD)PYRENE	NAPHTHALENE	PHENANTHRENE	PYRENE	BAP (EQ)
Category I Criteria				36.4	403	6,050	6,050	30,200	0.88	0.145	0.88	3,020	0.88	8.8	0.145	4,030	4,030	0.88	3.57	4,030	3,020	0.4
Category II On-Site Management Criteria				364	4,030	60,500	60,500	100,000	8.8	1.45	8.8	30,200	8.8	88	1.45	40,300	40,300	8.8	35.7	40,300	30,200	1.45
Maintenance Worker Screening Criteria				-	10,100	100,000	100,000	100,000	5.87	0.963	5.87	75,600	5.87	58.7	0.963	100,000	100,000	5.87	450	100,000	75,600	0.4
Off-Site Receptors Screening Criteria				-	-	-	-	-	11,500	1,150	11,500	-	11,500	115,000	2,670	-	-	11,500	3.57	-	-	0.4
Plant Ecological Screening Criteria				-	20	20	20	20	-	-	-	-	-	-	-	-	20	-	-	20	-	-
Invertebrate Ecological Screening Criteria				-	-	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-	-	-
UM3301	UM33	0.0 - 0.5	MG/KG	0.0055 U	0.0014 J	0.0055 U	0.0015 J	0.0015 J	0.0078	0.01	0.046	0.0091	0.0065	0.014	0.0055 U	0.019	0.0055 U	0.0055 U	0.0055 U	0.0091	0.015	0.015459
UM3401	UM34	0.0 - 0.5	MG/KG	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 J	0.0081	0.025 J	0.017	0.0036 J	0.012	0.0018 J	0.014	0.0055 U	0.0061	0.0055 U	0.0073	0.013	0.013608
UM3501	UM35	0.0 - 0.5	MG/KG	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0072	0.0093	0.054	0.012	0.0076	0.015	0.0055 U	0.02	0.0055 U	0.0055	0.0055 U	0.01	0.018	0.016061
UM3502	UM35	1.5 - 2.0	MG/KG	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0017 J	0.0055 U	0.0016 J	0.0055 U	0.0013 J	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0013 J	0.0000016
UM3601	UM36	0.0 - 0.5	MG/KG	0.027 U	0.027 U	0.041	0.019 J	0.057	0.19	0.17	0.48	0.11	0.098	0.24	0.034	0.45	0.022 J	0.085	0.027 U	0.27	0.43	0.28072
UM3701	UM37	0.0 - 0.5	MG/KG	0.0034 J	0.0013 J	0.0055 U	0.0055 U	0.0055 U	0.01	0.012	0.038	0.012	0.0081	0.019	0.0055 U	0.023	0.0023 J	0.0068	0.0016 J	0.011	0.022	0.01758
UM3702	UM37	1.5 - 2.0	MG/KG	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.0025 J	0.011 U	0.0031 J	0.011 U	0.011 U	0.011 U	0.011 U	0.0029 J	0.0000025
UM3801	UM38	0.0 - 0.5	MG/KG	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.0039 J	0.0056 J	0.015	0.0055 J	0.0028 J	0.013	0.011 U	0.01 J	0.011 U	0.011 U	0.011 U	0.0063 J	0.0094 J	0.007531
UM3802	UM38	1.5 - 2.0	MG/KG	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0013 J	0.0019 J	0.0055 U	0.0011 J	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0055 U	0.0001311
UM3901	UM39	0.0 - 0.5	MG/KG	0.0055 U	0.0013 J	0.0055 U	0.0055 U	0.0055 U	0.0068	0.0086	0.017	0.0079	0.0057	0.012	0.0013 J	0.015	0.0055 U	0.0048 J	0.0014 J	0.0097	0.014	0.012829
UM3902	UM39	1.5 - 2.0	MG/KG	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0.0056 U	0 U
UM4001	UM40	0.0 - 0.5	MG/KG	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U	0.0065 J	0.01 J	0.023	0.0085 J	0.0045 J	0.014 J	0.022 U	0.015 J	0.022 U	0.022 U	0.022 U	0.0099 J	0.016 J	0.013009
UM4101	UM41	0.0 - 0.5	MG/KG	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.0049 J	0.0095 J	0.015	0.0058 J	0.0053 J	0.0097 J	0.011 U	0.013	0.011 U	0.011 U	0.011 U	0.0066 J	0.011 J	0.0115527
UM4201	UM42	0.0 - 0.5	MG/KG	0.011 U	0.011 U	0.011 U	0.011 U	0.0023 J	0.012	0.015	0.03	0.0084 J	0.01 J	0.017	0.011 U	0.027	0.011 U	0.0054 J	0.011 U	0.015	0.027	0.019857
UM4202	UM42	1.5 - 2.0	MG/KG	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.0041 J	0.0066 J	0.0042 J	0.011 U	0.0031 J	0.011 U	0.0028 J	0.011 U	0.011 U	0.011 U	0.011 U	0.0027 J	0.0047631

See Table 5 for sources of maintenance worker, off-site receptor, plant, and invertebrate screening criteria. Category I criteria are based on the lowest of the calculated risk-based concentrations from the SCR, with the exception of BAP (EQ), which is based on the ambient value.
Category II criteria are based on 10 times the Category I criteria, with the exception of BAP (EQ), which is based on the 10 times the lowest of the calculated risk based concentrations. In cases where 10 times the Category I criteria is greater than 100,000 mg/kg, the default value of 100,000 mg/kg is used (Tetra Tech 2013).
No screening criteria are available for birds or mammals. None of the results exceed the plant or invertebrate screening criteria.
Chemicals that were not detected in any samples were excluded from this table. See Appendix A for full analytical results.
51 Outlined boxes indicate the result exceeds the Category I Screening Criteria

-	Not applicable	PAH	Polycyclic aromatic hydrocarbon
BAP (EQ)	Benzo(a)pyrene equivalency quotient	SCR	Site Characterization Report
MG/KG	Milligrams per kilogram	U	Nondetect
J	Estimated value		

Tetra Tech. 2013. Site Characterization Report. Research, Education, and Support Area and Groundwater within the Richmond Field Station Site. May 28.

Table 9: Upland Meadows Soil Detected PCB Compared to Human Health and Ecological Screening Criteria

Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID	Sample Location	Depth (feet bgs)	Units	AROCLOR-1248	AROCLOR-1254	AROCLOR-1260	TOTAL AROCLORS
			Category I Criteria	1	1	1	1
			Category II On-Site Management Criteria	1	1	1	1
			Maintenance Worker Screening Criteria	1	1	1	1
			Off-Site Receptors Screening Criteria	5,620	5,620	5,620	5,620
			Plant Ecological Screening Criteria	-	40	-	-
UM0101	UM01	0.0 - 0.5	MG/KG	0.013 U	0.0045 J	0.0033 J	0.0078
UM0102	UM01	1.5 - 2.0	MG/KG	0.014 U	0.014 U	0.014 U	U
UM0201	UM02	0.0 - 0.5	MG/KG	0.01 U	0.018	0.014 J	0.032
UM0301	UM03	0.0 - 0.5	MG/KG	0.013 U	0.0039 J	0.0037 J	0.0076
UM0401-FR1	UM04-R1	0.0 - 0.5	MG/KG	0.011 U	0.0065 J	0.0071 J	0.0136
UM0401-FR2	UM04-R2	0.0 - 0.5	MG/KG	0.01 U	0.041	0.012 J	0.037
UM0401-FR3	UM04-R3	0.0 - 0.5	MG/KG	0.015 UJ	0.016 J	0.0056 J	0.053
UM0402-FR1	UM04-R1	1.5 - 2.0	MG/KG	0.01 U	0.0037 J	0.01 U	U
UM0402-FR2	UM04-R2	1.5 - 2.0	MG/KG	0.011 U	0.011 U	0.011 U	0.0216
UM0402-FR3	UM04-R3	1.5 - 2.0	MG/KG	0.011 U	0.011 U	0.011 U	U
UM0501	UM05	0.0 - 0.5	MG/KG	0.013 U	0.012 J	0.0077 J	0.0197
UM0502	UM05	1.5 - 2.0	MG/KG	0.013 U	0.013 U	0.013 U	U
UM0601	UM06	0.0 - 0.5	MG/KG	0.013 U	0.038	0.0063 J	0.0443
UM0701	UM07	0.0 - 0.5	MG/KG	0.013 U	0.0071 J	0.0052 J	0.0123
UM0702	UM07	1.5 - 2.0	MG/KG	0.015 U	0.015 U	0.015 U	U
UM0801	UM08	0.0 - 0.5	MG/KG	0.013 U	0.013 U	0.013 U	U
UM0901	UM09	0.0 - 0.5	MG/KG	0.013 U	0.018	0.0068 J	0.0248
UM1001	UM10	0.0 - 0.5	MG/KG	0.013 U	0.018	0.0089 J	0.0269
UM1002	UM10	1.5 - 2.0	MG/KG	0.013 U	0.013 U	0.013 U	U
UM1101	UM11	0.0 - 0.5	MG/KG	0.013 U	0.01 J	0.0052 J	0.0152
UM1201	UM12	0.0 - 0.5	MG/KG	0.013 U	0.014	0.01 J	0.024
UM1202	UM12	1.5 - 2.0	MG/KG	0.013 UJ	0.013 UJ	0.013 UJ	U
UM1301	UM13	0.0 - 0.5	MG/KG	0.013 U	0.013 U	0.013 U	U
UM1401	UM14	0.0 - 0.5	MG/KG	0.013 U	0.0048 J	0.0024 J	0.0072
UM1402	UM14	1.5 - 2.0	MG/KG	0.013 U	0.013 U	0.013 U	U
UM1501	UM15	0.0 - 0.5	MG/KG	0.013 U	0.013 U	0.013 U	U
UM1601	UM16	0.0 - 0.5	MG/KG	0.013 U	0.013 U	0.013 U	U
UM1602	UM16	1.5 - 2.0	MG/KG	0.013 U	0.019	0.014 J	0.033
UM1701	UM17	0.0 - 0.5	MG/KG	0.01 U	0.022	0.01 U	0.022
UM1801	UM18	0.0 - 0.5	MG/KG	0.013 U	0.011 J	0.011 J	0.022
UM1802	UM18	1.5 - 2.0	MG/KG	0.013 U	0.013 U	0.013 U	U
UM1901-FR1	UM19-R1	0.0 - 0.5	MG/KG	0.013 U	0.039	0.011 J	0.05
UM1901-FR2	UM19-R2	0.0 - 0.5	MG/KG	0.013 U	0.024	0.0073 J	0.0313
UM1901-FR3	UM19-R3	0.0 - 0.5	MG/KG	0.011 U	0.013	0.0074 J	0.0204
UM2001	UM20	0.0 - 0.5	MG/KG	0.01 U	0.023	0.043 J	0.066

Table 9: Upland Meadows Soil Detected PCB Compared to Human Health and Ecological Screening Criteria

Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID	Sample Location	Depth (feet bgs)	Units	AROCLOR-1248	AROCLOR-1254	AROCLOR-1260	TOTAL AROCLORS
			Category I Criteria	1	1	1	1
			Category II On-Site Management Criteria	1	1	1	1
			Maintenance Worker Screening Criteria	1	1	1	1
			Off-Site Receptors Screening Criteria	5,620	5,620	5,620	5,620
			Plant Ecological Screening Criteria	-	40	-	-
UM2101	UM21	0.0 - 0.5	MG/KG	0.013 U	0.028	0.013 U	0.028
UM2102	UM21	1.5 - 2.0	MG/KG	0.013 U	0.013 U	0.013 U	U
UM2201	UM22	0.0 - 0.5	MG/KG	0.013 U	0.011 J	0.0053 J	0.0163
UM2301	UM23	0.0 - 0.5	MG/KG	0.013 U	0.013 U	0.013 U	U
UM2302	UM23	1.5 - 2.0	MG/KG	0.014 U	0.014 U	0.014 U	U
UM2401	UM24	0.0 - 0.5	MG/KG	0.013 U	0.021	0.011 J	0.032
UM2501	UM25	0.0 - 0.5	MG/KG	0.013 U	0.025	0.01 J	0.035
UM2502	UM25	1.5 - 2.0	MG/KG	0.013 U	0.013 U	0.013 U	U
UM2601	UM26	0.0 - 0.5	MG/KG	0.013 U	0.013 U	0.013 U	U
UM2701	UM27	0.0 - 0.5	MG/KG	0.013 U	0.03	0.015	0.045
UM2702	UM27	1.5 - 2.0	MG/KG	0.013 U	0.013 U	0.013 U	U
UM2801-FR1	UM28-R1	0.0 - 0.5	MG/KG	0.011 U	0.027	0.022	0.049
UM2801-FR2	UM28-R2	0.0 - 0.5	MG/KG	0.01 U	0.022	0.016	0.038
UM2801-FR3	UM28-R3	0.0 - 0.5	MG/KG	0.013 U	0.013 U	0.034	0.034
UM2901	UM29	0.0 - 0.5	MG/KG	0.3	0.35	0.044 J	0.694
UM2902	UM29	1.5 - 2.0	MG/KG	0.057	0.06	0.015 J	0.132
UM3001-FR1	UM30-R1	0.0 - 0.5	MG/KG	0.013 U	0.013 U	0.013 U	U
UM3001-FR2	UM30-R2	0.0 - 0.5	MG/KG	0.013 U	0.013 U	0.013 U	U
UM3001-FR3	UM30-R3	0.0 - 0.5	MG/KG	0.013 U	0.013 U	0.013 U	U
UM3002-FR1	UM30-R1	1.5 - 2.0	MG/KG	0.013 U	0.013 U	0.013 U	U
UM3002-FR2	UM30-R2	1.5 - 2.0	MG/KG	0.013 U	0.013 U	0.013 U	U
UM3002-FR3	UM30-R3	1.5 - 2.0	MG/KG	0.013 U	0.013 U	0.013 U	U
UM3101	UM31	0.0 - 0.5	MG/KG	0.013 U	0.02	0.0048 J	0.0248
UM3201	UM32	0.0 - 0.5	MG/KG	0.013 U	0.021	0.0064 J	0.0274
UM3202	UM32	1.5 - 2.0	MG/KG	0.013 U	0.013 U	0.013 U	U
UM3301	UM33	0.0 - 0.5	MG/KG	2.2	2.2	0.36	4.8
UM3401	UM34	0.0 - 0.5	MG/KG	0.011 U	0.023	0.01 J	0.033
UM3501	UM35	0.0 - 0.5	MG/KG	0.01 U	0.02	0.0074 J	0.0274
UM3502	UM35	1.5 - 2.0	MG/KG	0.011 U	0.011 U	0.011 U	U
UM3601	UM36	0.0 - 0.5	MG/KG	0.2	0.4	0.087	0.687
UM3701	UM37	0.0 - 0.5	MG/KG	0.013 U	0.066	0.017	0.083
UM3702	UM37	1.5 - 2.0	MG/KG	0.011 U	0.016	0.002 J	0.018
UM3801	UM38	0.0 - 0.5	MG/KG	0.011 U	0.012	0.0057 J	0.0177
UM3802	UM38	1.5 - 2.0	MG/KG	0.011 U	0.005 J	0.0024 J	0.0074
UM3901	UM39	0.0 - 0.5	MG/KG	0.011 U	0.023	0.0093 J	0.0323

Table 9: Upland Meadows Soil Detected PCB Compared to Human Health and Ecological Screening Criteria

Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID	Sample Location	Depth (feet bgs)	Units	AROCLOR-1248	AROCLOR-1254	AROCLOR-1260	TOTAL AROCLORS
			Category I Criteria	1	1	1	1
			Category II On-Site Management Criteria	1	1	1	1
			Maintenance Worker Screening Criteria	1	1	1	1
			Off-Site Receptors Screening Criteria	5,620	5,620	5,620	5,620
			Plant Ecological Screening Criteria	-	40	-	-
UM3902	UM39	1.5 - 2.0	MG/KG	0.011 U	0.0064 J	0.0046 J	0.011
UM4001	UM40	0.0 - 0.5	MG/KG	0.011 U	0.015	0.0067 J	0.0217
UM4101	UM41	0.0 - 0.5	MG/KG	0.013 U	0.053	0.025	0.078
UM4201	UM42	0.0 - 0.5	MG/KG	0.013 U	0.4	0.092	0.492
UM4202	UM42	1.5 - 2.0	MG/KG	0.014 U	0.017	0.014 U	0.017
UM4301	UM43	0.0 - 0.5	MG/KG	0.081	0.14	0.026	0.247
UM4302	UM43	1.5 - 2.0	MG/KG	0.098	0.42	0.061	0.579
UM4401	UM44	0.0 - 0.5	MG/KG	0.01 U	0.081	0.011	0.092
UM4402	UM44	1.5 - 2.0	MG/KG	0.01 U	0.27	0.054	0.324
UM4501	UM45	0.0 - 0.5	MG/KG	0.053	0.22	0.044	0.317
UM4502	UM45	1.5 - 2.0	MG/KG	0.15	0.27	0.065	0.485
UM4601	UM46	0.0 - 0.5	MG/KG	3	3	0.37	6.4
UM4602	UM46	1.5 - 2.0	MG/KG	26	11	0.93	38
UM4701	UM47	0.0 - 0.5	MG/KG	0.013 U	0.023	0.0092	0.0322
UM4702	UM47	1.5 - 2.0	MG/KG	0.019	0.025	0.0088	0.0528
UM4703	UM47	2.5 - 3.0	MG/KG	0.013	0.0092	0.0033	0.0255
UM4801	UM48	0.0 - 0.5	MG/KG	0.032	0.079	0.03	0.141
UM4802	UM48	1.5 - 2.0	MG/KG	0.019	0.043	0.017	0.079
UM4901	UM49	0.0 - 0.5	MG/KG	0.26	0.33	0.06	0.65
UM5001	UM50	0.0 - 0.5	MG/KG	1.6	1.9	0.28	3.8
UM5002	UM50	1.0 - 1.0	MG/KG	1.2	1.5	0.2	2.9
UM5101	UM51	0.0 - 0.5	MG/KG	1.4	1.7	0.26	3.4
UM5102	UM51	1.0 - 1.0	MG/KG	1.9	2.2	0.31	4.4

See Table 5 for sources of the off-site receptor and plant ecological screening criteria. Category I, Category II, and maintenance criteria are based on the TSCA High Occupancy, no further conditions threshold criterion for total PCBs from EPA (2005).

No screening criteria are available for invertebrates, birds, or mammals. None of the results exceed the plant screening criteria.

Chemicals that were not detected in any samples were excluded from this table. See Appendix A for full analytical results.

Total Aroclor values are calculated by summing the detected concentrations of Aroclors for each sample.

51	Outlined boxes indicate the result exceeds the Category I Screening Criteria
51	Gray highlights indicate the result exceeds either the Maintenance Worker Screening Criteria or Off-Site Receptors (Inhalation) Screening Criteria

EPA	U.S. Environmental Protection Agency	PCB	Polychlorinated biphenyl
MG/KG	Milligrams per kilogram	TSCA	Toxic Substances Control Act
J	Estimated value	U	Nondetect

EPA. 2005. PCB Site Revitalization Guidance Under the Toxic Substances Control Act. November. Available online at: http://www.epa.gov/osw/hazard/tsd/pcbs/pubs/pcb-guid3-06.pdf.

Table 10: Upland Meadows Soil Detected Pesticide Compared to Human Health and Ecological Screening Criteria
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID	Sample Location	Depth (feet bgs)	Units	4,4'-DDD	4,4'-DDE	4,4'-DDT	ALDRIN	ALPHA-BHC	ALPHA-CHLORDANE	BETA-BHC	DELTA-BHC	DIELDRIN	ENDOSULFAN I	ENDOSULFAN II	ENDOSULFAN SULFATE	ENDRIN	ENDRIN ALDEHYDE	GAMMA-BHC (LINDANE)	GAMMA-CHLORDANE	HEPTACHLOR	HEPTACHLOR EPOXIDE	METHOXYCHLOR
Category I Criteria				7.59	5.36	5.36	0.107	0.289	1.4	1.01	0.289	0.114	1,100	1,100	1,100	54.9	54.9	1.66	1.4	0.405	0.2	-
Category II On-Site Management Criteria				75.9	53.6	53.6	1.07	2.89	14	10.1	2.89	1.14	11,000	11,000	11,000	549	549	16.6	14	4.05	2	-
Maintenance Worker Screening Criteria				52.8	37.3	37.3	0.75	2.01	9.76	7.04	2.01	0.79	27,500	27,500	27,500	1,370	1,370	11.5	9.76	2.82	1.39	-
Off-Site Receptors Screening Criteria				46,400	33,000	33,000	654	1,780	9,420	6,040	1,780	696	-	-	-	-	-	10,300	9,420	2,460	1,230	-
Bird Ecological Screening Criteria				0.093	0.093	0.093	-	-	-	-	-	0.022	-	-	-	-	-	-	-	-	-	-
Mammal Ecological Screening Criteria				0.021	0.021	0.021	-	-	-	-	-	0.0049	-	-	-	-	-	-	-	-	-	-
UM0101	UM01	0.0 - 0.5	MG/KG	0.0018 J	0.0034 J	0.0039	0.0019 U	0.0019 U	0.00018 J	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0037 U	0.0037 U	0.0037 U	0.0037 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.019 U
UM0301	UM03	0.0 - 0.5	MG/KG	0.002 J	0.0037	0.0036 J	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.0037 U	0.0037 U	0.0037 U	0.0037 U	0.0019 U	0.0019 U	0.0019 U	0.0019 U	0.019 U
UM0901	UM09	0.0 - 0.5	MG/KG	0.035 U	0.029 J	0.029 J	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.035 U	0.035 U	0.035 U	0.035 U	0.018 U	0.018 U	0.018 U	0.018 U	0.18 U
UM2001	UM20	0.0 - 0.5	MG/KG	0.0017 J	0.0038	0.0069	0.0018 U	0.0018 U	0.0018 U	0.0018 U	0.0018 U	0.0018 U	0.0018 U	0.0036 U	0.0025 J	0.0036 U	0.002 J	0.0018 U	0.00046 J	0.0018 U	0.0018 U	0.014 J
UM2801-FR1	UM28-R1	0.0 - 0.5	MG/KG	0.0034 J	0.0074 J	0.0077 J	0.0014 J	0.0019 U	0.00038 J	0.00043 J	0.00041 J	0.00038 J	0.0019 U	0.0036 UJ	0.0017 J	0.00096 J	0.002 J	0.0019 U	0.0012 J	0.00054 J	0.00057 J	0.019 U
UM2801-FR2	UM28-R2	0.0 - 0.5	MG/KG	0.0013 J	0.014 J	0.0089 J	0.00086 J	0.0019 U	0.0019 U	0.00089 J	0.00085 J	0.0019 U	0.0003 J	0.0024 J	0.0036 U	0.00071 J	0.0028 J	0.0019 U	0.00077 J	0.00052 J	0.0017 J	0.0057 J
UM2801-FR3	UM28-R3	0.0 - 0.5	MG/KG	0.001 J	0.014 J	0.0068 J	0.00077 J	0.00047 J	0.0019 U	0.001 J	0.0019 U	0.0019 U	0.0012 J	0.0037 UJ	0.002 J	0.0037 U	0.00048 J	0.00044 J	0.00064 J	0.0016 J	0.0019 U	0.019 U
UM4001	UM40	0.0 - 0.5	MG/KG	0.018 U	0.016 J	0.019 J	0.0093 U	0.0093 U	0.0093 U	0.0093 U	0.0093 U	0.0093 U	0.0093 U	0.018 UJ	0.018 U	0.018 U	0.018 UJ	0.0093 U	0.0093 U	0.0093 U	0.0093 U	0.093 U

See Table 5 for sources of maintenance worker, off-site receptor, bird, and mammal screening criteria. Category I criteria are based on the lowest of the calculated risk-based concentrations from the SCR (Tetra Tech 2013). Category II criteria are based on 10 times the Category I criteria.
Plant and invertebrate screening criteria are not available.
Chemicals that were not detected in any samples were excluded from this table. See Appendix A for full analytical results.
51 Gray highlights indicate the result exceeds mammal criteria.
None of the results exceed human health screening criteria.

-	Not applicable	J	Estimated value	U	Nondetect
MG/KG	Milligrams per kilogram	SCR	Site Characterization Report		

Tetra Tech. 2013. Site Characterization Report. Research, Education, and Support Area and Groundwater within the Richmond Field Station Site. May 28.

Table 11: Carbon Tetrachloride Area Detected VOCs in Soil Gas

Phase IV Sampling Results, Technical Memorandum

University of California, Berkeley, Richmond Field Station Site

Sample ID/Sample Location	Depth (feet bgs)	Units	BENZENE	BTEX	CARBON TETRACHLORIDE	M-P-XYLENE	OCTANE	TOLUENE	TPH
SGCT1	2-3	µg	0.03	0.09	0.02 U	0.03	0.02 U	0.03	1.9
SGCT2	2-3	µg	0.02 U	0.02 U	0.03	0.02 U	0.02 U	0.02 U	1.73
SGCT3	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT4	2-3	µg	0.04	0.06	0.02 U	0.02 U	0.02 U	0.03	0.56
SGCT5	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT6	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT7-FR1	2-3	µg	0.02 U	0.02 U	0.05	0.02 U	0.02 U	0.02 U	0.5 U
SGCT7-FR2	2-3	µg	0.02 U	0.02 U	0.03	0.02 U	0.02 U	0.02 U	0.5 U
SGCT7-FR3	2-3	µg	0.03	0.06	0.02 U	0.02 U	0.02 U	0.03	0.74
SGCT8	2-3	µg	0.03	0.03	0.02 U	0.02 U	0.02 U	0.02 U	0.91
SGCT9	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT10	2-3	µg	0.02	0.05	0.02 U	0.02 U	0.02 U	0.03	0.5 U
SGCT11	2-3	µg	0.03	0.06	0.02 U	0.02 U	0.02 U	0.03	1.03
SGCTG12	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT13	2-3	µg	0.02	0.05	0.02 U	0.02 U	0.02 U	0.03	0.5 U
SGCT14	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT15	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	1.04
SGCT16	2-3	µg	0.02	0.02	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT17	2-3	µg	0.02 U	0.02 U	0.02	0.02 U	0.02 U	0.02 U	0.5 U
SGCT18	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT19	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT20	2-3	µg	0.02 U	0.02	0.02 U	0.02 U	0.02 U	0.02	0.5 U
SGCT21	2-3	µg	0.03	0.05	0.02 U	0.02 U	0.02 U	0.02	0.5 U
SGCT22-FR1	2-3	µg	0.04	0.09	0.02 U	0.02	0.02	0.03	1.35
SGCT22-FR2	2-3	µg	0.05	0.11	0.02 U	0.03	0.04	0.03	2.17
SGCT22-FR3	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT23	2-3	µg	0.03	0.06	0.02 U	0.02 U	0.02 U	0.03	0.5 U
SGCT24	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT25	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT26	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT27-FR1	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT27-FR2	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT27-FR3	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT28	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.56
SGCT29	2-3	µg	0.02	0.02	0.02 U	0.02 U	0.02 U	0.02 U	1.35

Table 11: Carbon Tetrachloride Area Detected VOCs in Soil Gas
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID/Sample Location	Depth (feet bgs)	Units	BENZENE	BTEX	CARBON TETRACHLORIDE	M-P-XYLENE	OCTANE	TOLUENE	TPH
SGCT30	2-3	µg	0.02	0.02	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT31	2-3	µg	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5 U
SGCT32	2-3	µg	0.02 U	0.02	0.03	0.02	0.02 U	0.02 U	0.5 U

Notes:
Non-detected VOCs include 1-1-1-2-tetrachloroethane, 1-1-1-trichloroethane, 1-1-2-2-tetrachloroethane, 1-1-2-trichloroethane, 1-1-dichloroethane, 1-1-dichloroethylene, 1-2-4-trimethylbenzene, 1-2-dichlorobenzene, 1-2-dichloroethane, 1-3-5-trimethylbenzene, 1-3-dichlorobenzene, 1-4-dichlorobenzene, 2-methylnaphthalene, acenaphthene, acenaphthylene, chlorobenzene, chloroform, cis-1-2-dichloroethylene, ethylbenzene, fluorene, methyl tert-butyl ether, naphthalene, o-xylene, pentadecane, tetrachloroethylene, trans-1-2-dichloroethylene, trichloroethylene, tridecane, undecane, and vinyl chloride.

Passive AGI universal soil gas samplers were used.

AGI	Amplified Geochemical Imaging
µg	Micrograms
bgs	Below ground surface
VOC	Volatile organic compound
U	Non-detect

Table 12: BAPB Area Groundwater Detected Metals Compared to Aquatic Screening Criteria
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID		Sample Location	Units	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	COBALT	IRON	MANGANESE	MERCURY	MOLYBDENUM	NICKEL	SELENIUM	THALLIUM	VANADIUM	ZINC
10 x Ambient Water Quality Criteria [1,2]				-	**220,000**	-	-	-	-	-	-	-	-	-	230,000	210,000	**320**	-	1,300,000
Marine Aquatic Toxicity Criteria [2,3]				-	-	**180**	-	-	**47**	-	-	-	**11**	-	**41**	**25**	-	-	**410**
20150202ETA01GW01		ETA01	UG/L	12 J	1 U	2	31	1 U	0.2 J	1.3	29 J	930	4.7	5.6	1 U	1 UJ	1 U	4.4	15
20150202ETA02GW01		ETA02	UG/L	50 U	1 U	3.1	19	1 U	0.52 J	1.5	250	660	0.2 U	3.3	27	0.63 J	1 U	2.9	27
20150202ETA02GW01D		ETA02	UG/L	50 U	1 U	2.7	19	1 U	0.54 J	1.6	200	700	0.2 U	2.2	27	0.36 J	1 U	3.1	40
20150202ETA03GW01		ETA03	UG/L	30 J	0.41 J	0.63 J	22	0.16 J	2.5	110	12,000	18,000	0.2 U	1.1	140	0.62 J	0.24 J	0.5 J	1,200
20150202WSM01GW01		WSM01	UG/L	34 J	1 U	4	16	1 U	1 U	14	1,300	6,600	0.2 U	2.3	1 U	1 UJ	1 U	0.62 J	200

Chemicals that were not detected in any samples were excluded from this table. See Attachment 3 for full analytical results.

51 Gray highlights indicate the result exceeds Marine Aquatic Toxicity Criteria. No sample results exceeded ten times the AWQC criteria.

1 Based on 10 times the surface water AWQC for human consumption of aquatic organisms, with a dilution factor of 5 applied (see note 4). Human health criteria based on consumption of aquatic organisms are from the following sources in order of preference: CTR (EPA 2000) and the NRWQC (EPA 2006a). The aquatic screening criteria is based on 10 times those values to allow for dilution and attenuation in the bulk surface water (e.g., tidal surface water in the marsh).

2 **Bold values** indicate selected criteria (the lesser of the two screening criteria listed).

3 Based on the marine aquatic toxicity criteria, with a dilution factor of 5 applied (see note 4). Marine aquatic toxicity criteria are the continuous concentration criteria, where available, from the more stringent of the Basin Plan (RWQCB 2006) or the CTR (U.S. EPA 2000), the NRWQC (EPA 2006b), and the PER (1999).

4 The dilution factor of 5 for groundwater near the BAPB was developed and presented in Appendix I of the Draft Feasibility Study and Remedial Action Plan for Lots 1, 2, and 3 of the neighboring Campus Bay facility (EKI 2008).

-	Not applicable	J	Estimated value
µg/L	Micrograms per liter	NRWQC	National Recommended Water Quality Criteria
AWQC	Ambient water quality criteria	PER	Pacific EcoRisk
BAPB	Biologically active permeable barrier	RWQCB	San Francisco Bay Regional Water Quality Control Board
CTR	California Toxics Rule	U	Nondetect
EPA	U.S. Environmental Protection Agency	VOC	Volatile organic compound

References:

EKI. 2008. Draft Feasibility study and Remedial Action Plan for Lots 1, 2, and 3, Campus Bay Site, Richmond, California, April 30, 2008.

EPA. 2000. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic for the State of California; Rule, Federal Register 40 CAR Part 131, May 2000, available at: http://www.epa.gov/waterscience/standards/ctr/toxic.pdf.

EPA. 2002. National Toxics Rule. 40 CFR Ch I (7-1-02). Section 131.36. U.S. Environmental Protection Agency. 2002.

EPA. 2006a. Code of Federal Regulations. Title 40, Part 131 - Water Quality Standards. U.S. Environmental Protection Agency.

EPA. 2006b. National Recommended Water Quality Criteria. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology. Available at: http://epa.gov/waterscience/criteria/nrwqc2006.pdf

PER. 1999. Sediment Quality in Stege Marsh: 1. Ecological Risk Assessment. Pacific EcoRisk.

RWQCB. 2006. Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin. San Francisco Bay Regional Water Quality Control Board, December.

Table 13: BAPB Area Groundwater Detected VOCs Compared to Aquatic Screening Criteria
Phase IV Sampling Results, Technical Memorandum
University of California, Berkeley, Richmond Field Station Site

Sample ID		Sample Location	Units	1,1,2-TRICHLOROETHANE	1,1-DICHLOROETHYLENE	1,2-DICHLOROETHANE	2-BUTANONE	ACETONE	BENZENE	CHLOROBENZENE	CHLOROFORM	CIS-1,2-DICHLOROETHYLENE	METHYL TERT-BUTYL ETHER	TERT BUTYL ALCOHOL	TETRACHLOROETHYLENE	TRANS-1,2-DICHLOROETHENE	TRICHLOROETHYLENE	VINYL CHLORIDE
10 x Ambient Water Quality Criteria [1,2]				2,100	160	5,000	-	-	3,600	1,100,000	24,000	-	-	-	440	7,000,000	4,100	26,000
20150202ETA01GW01		ETA01	µg/L	0.5 U	0.3 J	0.2 J	10 U	10 U	0.5 U	0.5 U	0.5 U	2.3	0.5 U	10 UJ	0.5 U	0.5 U	15	0.2 J
20150202ETA02GW01		ETA02	µg/L	0.5 U	0.9	12	10 U	10 U	0.1 J	4.1	0.2 J	6.3	0.5 U	10 UJ	14	0.7	56	0.1 J
20150202ETA02GW01D		ETA02	µg/L	0.5 U	0.8	12	10 U	10 U	0.5 U	4.1	0.2 J	6.7	0.5 U	2.1 J	14	0.7	57	0.5 U
20150202ETA03GW01		ETA03	µg/L	0.2 J	1.2	15	0.3 J	10 U	0.2 J	4.5	0.2 J	9	0.5 U	2.7 J	25	1	60	0.5 U
20150202WSM01GW01		WSM01	µg/L	0.5 U	0.5 J	1.6	190	74	0.2 J	7.1	0.5 U	6.4	0.2 J	10 UJ	4.2	0.4 J	68	0.5 U

Chemicals that were not detected in any samples were excluded from this table. See Attachment 3 for full analytical results.

1 Based on 10 times the surface water AWQC for human consumption of aquatic organisms, with a dilution factor of 5 applied (see note 2). Human health criteria based on consumption of aquatic organisms are from the following sources in order of preference: CTR (EPA 2000) and the NRWQC (EPA 2006). The aquatic screening criteria is based on 10 times those values to allow for dilution and attenuation in the bulk surface water (e.g., tidal surface water in the marsh). No marine toxicity criteria are available.

2 The dilution factor of 5 for groundwater near the BAPB was developed and presented in Appendix I of the Draft Feasibility Study and Remedial Action Plan for Lots 1, 2, and 3 of the neighboring Campus Bay facility (EKI 2008).

-	Not applicable	J	Estimated value
µg/L	Micrograms per liter	NRWQC	National Recommended Water Quality Criteria
AWQC	Ambient water quality criteria	U	Nondetect
BAPB	Biologically active permeable barrier	VOC	Volatile organic compound
EPA	U.S. Environmental Protection Agency		

References:

EKI. 2008. Draft Feasibility study and Remedial Action Plan for Lots 1, 2, and 3, Campus Bay Site, Richmond, California, April 30, 2008.

EPA. 2000. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic for the State of California; Rule, Federal Register 40 CAR Part 131, May 2000, available at: http://www.epa.gov/waterscience/standards/ctr/toxic.pdf.

EPA. 2006a. Code of Federal Regulations. Title 40, Part 131 - Water Quality Standards. U.S. Environmental Protection Agency.