Aspect
CONSULTING

May 10, 2018

Mr. Ed Jones
Washington State Department of Ecology, NWRO
3190 160th Avenue SE
Bellevue, Washington 98008-5452

**Re: West of 4th Site Agreed Order #DE10402 and Amendment #DE15344**
Revised Capital Industries Plant 4 Stage 1 Field Implementation Work Plan

Dear Mr. Jones:

Please find enclosed the Revised Capital Industries Plant 4 Stage 1 Field Implementation Work Plan. This report was prepared by Farallon Consulting on behalf of the four potentially liable persons (PLPs) [Art Brass Plating, Blaser Die Casting, Capital Industries, and PSC Environmental Services, LLC] identified by Ecology in the Agreed Order #DE10402 for the West of 4th Site.

Sincerely,

Dana Cannon

**Dana Cannon, LHG**
W4 Project Coordinator
dcannon@aspectconsulting.com

Attachments: Revised Capital Industries Plant 4 Stage 1 Field Implementation Work Plan

# REVISED CAPITAL INDUSTRIES PLANT 4
# STAGE 1 FIELD IMPLEMENTATION WORK PLAN

**West of 4th Group Site**
**Capital Industries, Inc.**
**5801 3rd Avenue South**
**Seattle, Washington**

**Submitted by:**
**Farallon Consulting, L.L.C.**
**975 5th Avenue Northwest**
**Issaquah, Washington 98027**

**Farallon PN: 457-008**

**For:**
**West of 4th Avenue Group**
**Site Unit 2 Joint Deliverable**
**Capital Industries, Inc.**
**Blaser Die Casting Co.**
**Stericycle**
**Seattle, Washington**

May 10, 2018

Prepared by:

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Reviewed by:

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Principal Geologist

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| bgs | below ground surface |
| Cascade | Cascade Technical Services |
| CI | Capital Industries, Inc. |
| cis-1,2-DCE | cis-1,2-dichloroethene |
| COCs | constituents of concern |
| CVOCs | chlorinated volatile organic compounds |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| Farallon | Farallon Consulting, L.L.C. |
| HASP | Health and Safety Plan |
| Interim Action Work Plan | *Final Capital Industries Plant 4 Interim Action Work Plan, West of 4th Group Site, Capital Industries, Inc., 5815 4th Avenue South, Washington* dated December 21, 2017, prepared by Farallon Consulting, L.L.C. |
| ISCO | in-situ chemical oxidation |
| ITRC | Interstate Technology Regulatory Council |
| PCE | tetrachloroethene |
| PCULs | preliminary cleanup levels |
| PGG | Pacific Groundwater Group |

| | |
|---|---|
| QAPP | *Quality Assurance Project Plan*, *Appendix D of the Revised Capital Industries Plant 4 Stage 1 Field Implementation Work Plan, West of 4th Group Site, Capital Industries, Inc., 5801 3rd Avenue South, Seattle, Washington* dated May 10, 2018, prepared by Farallon Consulting, L.L.C. |
| RI | Remedial Investigation |
| ROI | radius of influence |
| SAP | *Sampling and Analysis Plan*, *Appendix C of the Revised Capital Industries Plant 4 Stage 1 Field Implementation Work Plan, West of 4th Group Site, Capital Industries, Inc., 5801 3rd Avenue South, Seattle, Washington* dated May 10, 2018, prepared by Farallon Consulting, L.L.C. |
| Site | the West of 4th Group Site consisting of Site Unit 1 and Site Unit 2 |
| SU2 | Site Unit 2 |
| SU2 FS Report | *West of Fourth Site Unit 2 Feasibility Study, Seattle, Washington* dated August 11, 2016, prepared by the West of Fourth Group and Pacific Groundwater Group |
| TCE | trichloroethene |
| UIC | underground injection control |
| West of 4th Group | Art Brass Plating, Inc.; Blaser Die Casting Co.; Capital Industries, Inc.; and Burlington Environmental, LLC |
| Work Plan | *Revised Capital Industries Plant 4 Stage 1 Field Implementation Work Plan, Site Unit 2, Seattle, Washington* dated May 10, 2018, prepared by Farallon Consulting, L.L.C. (this document) |

# 1.0 INTRODUCTION

Farallon Consulting, L.L.C. (Farallon) has prepared this Revised Capital Industries Plant 4 Stage 1 Field Implementation Work Plan (Work Plan) on behalf of Art Brass Plating, Inc.; Blaser Die Casting Co.; Capital Industries, Inc. (CI); and Burlington Environmental, LLC[1] (collectively referred to herein as the West of 4th Group), which are the potentially liable parties for the West of 4th Group Site (herein referred to as the Site), which consists of Site Unit 1 and Site Unit 2 (SU2), depicted on Figure 1. The Art Brass Plating, Inc. property is located at Site Unit 1. The CI and Blaser Die Casting Co. properties are located at SU2. The CI property comprises five buildings identified as Plants 1 through 5 (Figure 2). The Work Plan provides the technical approach to an interim action at CI Plant 4 that is being conducted on behalf of the West of 4th Group.

This Work Plan has been prepared in accordance with the requirements of Agreed Order No. DE 10402 entered into by the West of 4th Group and the Washington State Department of Ecology (Ecology) in April 2014; the First Amendment to Agreed Order No. DE 10402 dated November 20, 2017; and the Washington State Model Toxics Control Act Cleanup Regulation, as established in Chapter 173-340 of the Washington Administrative Code.

## 1.1 OBJECTIVES

The purpose of the Work Plan is to provide the details for implementation of the in-situ chemical oxidation (ISCO) interim action at CI Plant 4 (Figure 2), in SU2 as discussed in the *West of 4th Site Unit 2 Feasibility Study, Seattle, Washington* dated August 11, 2016, prepared by West of Fourth Group and Pacific Groundwater Group (PGG) (2016) (SU2 FS Report) and in the Final Capital Industries Plant 4 Interim Action Work Plan, West of 4th Group Site dated December 21, 2017 prepared by Farallon (2017b) (Interim Action Work Plan). The ISCO technology that will be used includes direct injection of potassium permanganate ($KMnO_4$) into the subsurface to treat shallow

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[1] Burlington Environmental, LLC, is a wholly owned subsidiary of PSC Environmental Services, LLC, which is a wholly owned subsidiary of Stericycle Environmental Solutions, Inc.

soil and groundwater. The interim action objectives are tied to the remedial action objectives for the Site, described in the SU2 FS Report, and include:

- Reducing concentrations of chlorinated volatile organic compounds (CVOCs) in soil beneath CI Plant 4 to concentrations less than the preliminary cleanup levels (PCULs) for the Site to reduce inhalation risks to acceptable levels (Table 1); and
- Reducing concentrations of CVOCs in shallow groundwater that allegedly originated from CI Plant 4 to concentrations less than the PCULs for the Site.

## 1.2 ORGANIZATION

This Work Plan summarizes pertinent background information and provides details for implementation of the ISCO interim action at SU2. This Work Plan is organized into the following sections:

- **Section 1, Introduction,** presents an overview of the Site, and the objectives and organization of the Work Plan.
- **Section 2, Background,** presents background information, including a summary of previous investigations conducted at CI Plant 4, and a description of the constituents of concern (COCs) that will be targeted during the interim action.
- **Section 3, Preliminary Cleanup Levels,** presents the revised PCULs for the Site.
- **Section 4, Conceptual Site Model,** presents a description of the Site features, geology, and hydrogeology; the nature and extent of contamination; and groundwater geochemistry.
- **Section 5, Interim Action,** presents a description of the interim action, including a discussion of the remedial technology, permitting, health and safety, spill prevention, utility clearance, baseline groundwater sampling, the interim action approach and design, Stage 1 injectability testing, and the process and performance monitoring programs.
- **Section 6, Interim Action Documentation,** presents a description of documents that will be generated during the interim action activities.

- **Section 7, Schedule and Reporting,** summarizes the schedule for implementation of the interim action and associated reporting deliverables that will be submitted to Ecology.
- **Section 8, References,** lists the documents cited in this Work Plan.

# 2.0 BACKGROUND

This section presents background information, including a summary of previous investigations conducted at Plant 4, and a description of the COCs that will be targeted during the interim action.

## 2.1 PREVIOUS INVESTIGATIONS AT CI PLANT 4

Former operations at the CI property allegedly have resulted in releases of tetrachloroethene (PCE) and/or trichloroethene (TCE) to soil and groundwater. Details of historical CI operations and the results from prior environmental investigations, including a Remedial Investigation (RI) conducted by Farallon, are presented in the *Revised Draft Remedial Investigation Report, Capital Industries, Inc., 5801 3rd Avenue South, Seattle, Washington, Agreed Order No. DE 5348* dated October 2012, prepared by Farallon (2012). A hot solvent degreaser and associated former drum storage area historically were present in the south-central and west-central portions of CI Plant 4, respectively. The hot solvent degreaser was used in CI Plant 4 from approximately 1987 to 1992 and was removed in 1993.

During subsurface investigations conducted by Farallon (2012) at CI Plant 4 during the RI, neither TCE nor PCE was detected in soil samples collected from the boring/monitoring well locations at concentrations that accounted for the impacts to groundwater quality that occurred at and down-gradient of CI Plant 4. Concentrations of CVOCs detected in groundwater samples collected from the Water Table Interval (depths of from 0 to 20 feet below ground surface [bgs]) and/or the Shallow Interval (depths at and from 20 to 40 feet bgs) near the suspected source areas previously identified at the CI property suggest there may be areas where concentrations of CVOCs in soil are greater than those detected during the RI. Therefore, Ecology required that additional investigation be conducted at CI Plant 4.

Farallon (2016) conducted passive soil gas and bulk soil sampling at CI Plant 4 and in the South Fidalgo Street right-of-way to assess the lateral and vertical distribution of PCE and TCE in soil beneath CI Plant 4 to resolve data gaps associated with the RI for the CI property, described in the revised data gap memorandum for Site Unit 2 (Farallon 2015).

The soil gas survey results indicated that the highest concentrations of PCE in soil gas were present in an area extending from the east-central portion to the south-southwestern portion of CI Plant 4 (Figures 3A through 3C). The areas with the highest concentrations of TCE in soil gas correlated with the areas with the highest concentrations of PCE in soil gas. Elevated concentrations of TCE were detected also in the approximate location of the former drum storage area (Figure 3B).

The highest concentration of cis-1,2-dichloroethene (cis-1,2-DCE) in soil gas was detected at the east-central portion of CI Plant 4, and correlates with the locations of the highest concentrations of PCE and TCE (Figure 3C). The PCE, TCE, and cis-1,2-DCE data indicate potential releases at the former drum storage area at the west-central portion of CI Plant 4, at the former degreaser location at the south-central portion of the building, and at the east-central portion of the building. Soil sampling at these locations was conducted to supplement existing soil data from the RI and further evaluate the nature and extent of COCs in soil. Concentrations of PCE, TCE, and cis-1,2-DCE detected in soil gas at the east-central portion of CI Plant 4 could be the result of a release on the east-adjacent Pacific Food Systems property or encroachment of contamination from other areas beneath CI Plant 4. The specific source of CVOCs in soil gas on the Pacific Food Systems property is undetermined.

PCE was detected at concentrations exceeding the PCUL for air quality protection and/or the revised PCUL[2] for surface water quality protection in soil samples collected from borings P4-B6, P4-B7, P4-B8, and P4-B11 (Table 2; Figure 3A). The maximum PCE concentration detected was 0.64 milligram per kilogram at boring P4-B6, located in the southeastern portion of CI Plant 4, east of the former degreaser.

TCE was detected at concentrations exceeding the PCUL for air quality protection and/or the revised PCUL for surface water quality protection in soil samples collected from borings P4-B1, P4-B3 through P4-B9, and P4-B14 (Table 2; Figure 3B). The maximum TCE concentration

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[2] Certain PCULs were revised in January 2017 to accommodate U.S. Environmental Protection Agency (EPA) revisions to surface water quality criteria.

detected was 0.48 milligram per kilogram at boring P4-B7, located in the central portion of CI Plant 4.

Cis-1,2-DCE, trans-1,2-dichloroethene, and vinyl chloride were not detected at concentrations exceeding PCULs in the soil samples collected at and proximate to CI Plant 4 (Table 2; Figures 3A through 3C).

The soil analytical results indicate that the highest concentrations of CVOCs are present immediately beneath the CI Plant 4 building slab, and attenuate with depth. PCE and TCE were detected at low concentrations at CI Plant 4, which confirms that there was not a significant or extensive release of PCE or TCE at CI Plant 4. The groundwater data from the RI Report (Farallon 2012) and post-RI sampling also support the conclusions drawn from the soil data. The concentrations of COCs in the Water Table Interval are not indicative of a major release of PCE or TCE (Table 3; Figure 4). PCE or TCE was not detected in either the Shallow or Intermediate Groundwater Interval (depths greater than 40 feet bgs), indicating that the release(s) of PCE and TCE that did occur were of insufficient mass and/or volume to affect deeper groundwater.

Sufficient data were collected at CI Plant 4 to evaluate potential cleanup technologies for soil and groundwater, described in the SU2 FS Report. The potential active cleanup technologies evaluated and the media to be remediated were:

- ISCO (soil and groundwater);
- Soil excavation and off-Site disposal (soil);
- Soil vapor extraction/air sparging (soil and groundwater);
- Enhanced anaerobic biodegradation (groundwater); and
- In-situ chemical reduction (groundwater).

ISCO was the preferred cleanup technology for soil and groundwater due to its ability to be implemented with minimal interference with operations at CI Plant 4, and its ability to rapidly treat the low levels of CVOCs present in soil and groundwater (West of Fourth Group and PGG 2016).

## 2.2 CONSTITUENTS OF CONCERN FOR INTERIM ACTION

The COCs for soil are PCE and TCE. These COCs are a current and future risk to the soil-to-groundwater and soil-to-indoor-air pathways. The COCs for groundwater in the Water Table Interval are PCE and TCE. These COCs are a current and future risk to the groundwater-to-surface water and groundwater-to-indoor air pathways. PCE and TCE also have the potential to affect the Shallow Interval where anaerobic conditions exist and reductive dechlorination to vinyl chloride can occur. Oxidation of PCE and TCE in the Water Table Interval reduces the risk of vinyl chloride generation.

# 3.0 PRELIMINARY CLEANUP LEVELS

The PCULs for the Site are based on potential exposure pathways, and were defined in the Technical Memorandum regarding Revised Preliminary Cleanup Standards, W4 Joint Deliverable, Seattle, Washington dated September 12, 2014, from Farallon (2014) to Mr. Ed Jones of Ecology. The PCULs were updated on January 17, 2017 to reflect updates to human health criteria in the Clean Water Act promulgated by EPA on November 15, 2016.

The current PCULs for the Site are summarized in Table 1 of this Work Plan.

# 4.0 CONCEPTUAL SITE MODEL

This section presents a summary of the conceptual site model elements pertinent to the ISCO injection work described herein.

## 4.1 GEOLOGY

Soil conditions at CI Plant 4 consisted of approximately 1 foot of silty sand underlain by silt with sand to depths ranging from approximately 6 to 7.5 feet bgs, underlain by fine sand with trace silt to the maximum depth explored of 18 feet bgs. Groundwater generally was encountered at a depth of 8 to 9 feet bgs. The silty sand layer near the ground surface pinches out in the South Fidalgo Street right-of-way.

## 4.2 HYDROGEOLOGY

The hydrogeologic units at the Site are:

- The Water Table Interval, extending to a depth of up to 20 feet bgs.
- The Shallow Interval, ranging in depth from 20 to 40 feet bgs.
- The Intermediate Interval, which includes groundwater monitored at the Site at depths below 40 feet bgs.

Groundwater in these three hydrogeologic units flows to the west and southwest toward the Duwamish River, with little seasonal fluctuation. A downward vertical gradient is present between the Water Table and Shallow Intervals. The vertical gradients between the Shallow and Intermediate Intervals fluctuate between upward and downward in monitoring well clusters east of East Marginal Way. The vertical gradient between the Shallow and Intermediate Intervals in monitoring well clusters west of East Marginal Way, proximate to the Duwamish River, generally is upward.

Tidal studies were documented in RI reports prepared for Art Brass Plating, Inc. (Aspect Consulting 2012) and CI (Farallon 2012). Water levels in the western portions of the Site are tidally influenced by Puget Sound. This tidal influence is demonstrated in localized, transient flow reversals similar to those observed at other sites near the Duwamish River. Tidal flow reversals diminish to 0.5 foot or less, 800 feet east-northeast of the Duwamish River.

## 4.3 NATURE AND EXTENT OF CONTAMINATION

The following sections present the nature and extent of contamination observed in soil gas, soil, and groundwater.

### 4.3.1 Soil Gas

The highest concentrations of PCE and TCE in soil gas were detected in an area extending from the east-central to the south-southwestern portions of CI Plant 4 (Figures 3A through 3C). The highest concentration of cis-1,2-DCE in soil gas was detected in the east-central portion of CI Plant 4, and correlates with the locations of the highest concentrations of PCE and TCE (Figure 3C).

### 4.3.2 Soil

The highest concentrations of PCE and TCE in the borings advanced at and proximate to CI Plant 4 were detected at a depth of approximately 1 foot bgs. Additional soil samples with concentrations of PCE and TCE exceeding PCULs were collected in silty material at borings P4-B1, P4-B4 through P4-B8, and P4-B14, located primarily at the southeastern portion of CI Plant 4 and the northern right-of-way of South Fidalgo Street. The vertical extent of soil contamination exceeding PCULs appears to be less than 10 feet bgs (Figures 3A through 3C).

### 4.3.3 Groundwater

PCE and TCE in the Water Table Interval allegedly originated from a former degreaser that was present on the south-central portion of CI Plant 4. CVOCs in groundwater in the Water Table, Shallow, and Intermediate Intervals, including PCE, TCE, and vinyl chloride, migrate to the southwest in SU2, toward Slip 2 at the Lower Duwamish Waterway (Aspect Consulting 2014). The portion of the interim action that addresses groundwater will be focused on the Water Table Interval. The interim action will not extend into the Shallow Interval, because the up-gradient plume from other sources will re-contaminate the remediated groundwater, and reductive dechlorination is occurring in the Shallow and Intermediate Intervals at a rate that will achieve the PCULs in a reasonable restoration time frame.

## 4.4 GROUNDWATER GEOCHEMISTRY

The groundwater at the Site generally is anaerobic and conducive to reductive dechlorination of CVOCs via microbial biodegradation. However, the Water Table Interval overall is the least reducing of the groundwater intervals, bordering on aerobic to anoxic conditions, whereas reducing conditions increase with depth (Farallon 2017a). Table 4 presents the geochemical data for monitoring wells MW-6 and MW-7, which are in the interim action area and will be monitored for changes in geochemistry resulting from ISCO injections.

# 5.0 INTERIM ACTION

This section presents a description of the interim action, including a discussion of the remedial technology, permitting, health and safety, spill prevention, utility clearance, baseline groundwater monitoring, interim action approach and design, Stage 1 injectability testing, and process and performance monitoring.

## 5.1 REMEDIAL TECHNOLOGY

Permanganate is a non-specific oxidizer of contaminants, meaning it will oxidize COC and natural organic materials in the soil. It can be used over a wide range of pH values and does not require a catalyst. Permanganate is a stable oxidant and can persist in the subsurface for months, allowing for more contaminant contact and the potential for reducing rebound. As permanganate oxidizes organic materials, including COCs, manganese oxide forms as a dark brown to black precipitate. Prior to oxidation, permanganate has a purple color.

Sodium permanganate and $KMnO_4$ were evaluated as possible chemical oxidants for the interim action. $KMnO_4$ is appropriate for this interim action due to the low concentrations of COCs present beneath CI Plant 4, and its ease of use (i.e., it ships to the Site as a solid, is not as highly reactive as sodium permanganate, and is not as hazardous for workers to handle in the field) (The Interstate Technology & Regulatory Council [ITRC] 2005). The oxidation of CVOCs by $KMnO_4$ is described by the following reactions:

**<u>PCE</u>**

$$3C_2Cl_4 + 4KMnO_4 + 4H_2O \rightarrow 6CO_2 + 4MnO_2(s) + 4K^+ + 12Cl^- + 8H^+$$

Where:

$C_2Cl_4$ = PCE

$H_2O$ = water

$CO_2$ = carbon dioxide

$MnO_2(s)$ = manganese dioxide as a solid

$K^+$ = potassium ion

$Cl^-$ = chlorine ion

$H^+$ = hydrogen ion

## TCE

$C_2HCl_3 + 2KMnO_4 \rightarrow 2MnO_2 + 3Cl^- + H^+ + 2CO_2(g) + 2K^+$

Where:

$C_2HCl_3$ = TCE

$MnO_2$ = manganese dioxide

$Cl^-$ = chlorine ion

$H^+$ = hydrogen ion

$CO_2(g)$ = carbon dioxide as a gas

$K^+$ = potassium ion

## cis-1,2-DCE

$3C_2H_2Cl_2 + 8KMnO_4 + 2H^+ \rightarrow 6CO_2 + 8MnO_2(s) + 8K^+ + 6Cl^- + 4H_2O$

Where:

$C_2H_2Cl_2$ = cis-1,2-DCE

$H^+$ = hydrogen ion

$CO_2$ = carbon dioxide

$MnO_2(s)$ = manganese dioxide as a solid

$K^+$ = potassium ion

$Cl^-$ = chlorine ion

$H_2O$ = water

**Vinyl chloride**

$3C_2H_3Cl + 10KMnO_4 \rightarrow 6CO_2 + 10MnO_2(s) + 10K^+ + 3Cl^- + 7OH^- + H_2O$

Where:

$C_2H_3Cl$ = vinyl chloride

$CO_2$ = carbon dioxide

$MnO_2(s)$ = manganese dioxide as a solid

$K^+$ = potassium ion

$Cl^-$ = chlorine ion

$OH^-$ = hydroxide ion

$H_2O$ = water

In general, CVOCs with higher chlorine substitution consume less oxidant (per the stoichiometric requirement) and produce fewer manganese dioxide solids. Four moles of permanganate are needed to mineralize 3 moles of PCE producing 4 moles of manganese dioxide solids, compared to 10 moles of permanganate needed to mineralize 3 moles of vinyl chloride producing 10 moles of manganese dioxide solids. These equations represent the minimum amount of $KMnO_4$ necessary to oxidize the CVOCs.

Distribution of $KMnO_4$ will be implemented through direct-push ISCO injection points to force the oxidant into the formation. The approach and design of the oxidant delivery are presented in Section 5.7, Interim Action Approach and Design; injection monitoring is presented in Section 5.9, Process and Performance Monitoring. Preliminary steps, including permitting, health and safety, spill prevention planning, utility clearance, and baseline groundwater sampling, are discussed in the following sections.

## 5.2 PERMITTING

Ecology requires an Underground Injection Control (UIC) permit prior to injection of any material into groundwater. Farallon will secure the UIC permit for the ISCO injection. Ecology issued a State Environmental Policy Act threshold determination of non-significance for the interim action in 2017.

## 5.3 HEALTH AND SAFETY

A Health and Safety Plan (HASP) is required for all field activities (Section 810 of Chapter 173-340 of the Washington Administrative Code). Farallon and all subcontractors will be required to provide HASPs for their own employees that are appropriate to their role in the interim action and in accordance with the laws under which their work is regulated. Farallon's HASP will comply with the requirements of the Occupational Safety and Health Act of 1970 and the Washington Industrial Safety and Health Act (Chapter 49.17 of the Revised Code of Washington). Handling, storage, and incompatibility associated with $KMnO_4$ are discussed in the safety data sheet and fact sheet provided by Carus Corporation, the supplier of the $KMnO_4$, which is provided as Attachment 10 of the draft project-specific HASP prepared by Farallon (Appendix A of this Work Plan). Ecology approval of the HASP is not required.

Farallon and subcontractor personnel will be required to have 40-Hour Hazardous Waste Operations and Emergency Response training as hazardous waste operators in accordance with Part 1910.120 of Title 29 of the Code of Federal Regulations.

Skin and eye contact with oxidizing chemicals should be avoided, and special care should be taken to avoid breathing the chemicals in the form of dust or mist. Accordingly, proper personal protective equipment should be employed per the safety data sheet, and workers should handle the chemicals in a manner that minimizes creation of dust or mist. Proper respiratory, eye, face, and skin protection always should be worn during work involving exposure to these chemicals.

Prior to each injection, a safety meeting will be held to discuss specific concerns for each ISCO injection point. The depth interval, desired flow rate, and desired injection pressure will be discussed. The location of spill kits necessary to neutralize, contain, and recover $KMnO_4$ that could surface will be discussed. The location of underground utilities and other underground structures near the injection point will be identified, clearly marked, and discussed.

Workers at CI and at east-adjacent Pacific Foods Services will be notified of the work, and asked to notify the Farallon Project Manager and/or Site Health and Safety Officer if they observe anything unusual that may be connected with the interim action.

## 5.4 SPILL PREVENTION

The injection equipment and tote used for mixing the 3 percent $KMnO_4$ solution being injected will be placed within secondary containment compatible with the $KMnO_4$ solution, and capable of holding 100 percent of the volume of the tote. A spill kit with items capable of neutralizing, containing, and absorbing a potential spill will be present when the 3 percent $KMnO_4$ solution is being mixed, and when it is being injected into the subsurface. Photographs of the injection equipment and spill kits provided by Cascade Technical Services (Cascade), the equipment owner and designer, are provided in Appendix B.

Sudden changes in injection rates and pressure usually are the first signs of oxidant surfacing during pressurized ISCO injection. If surfacing occurs, injection will be stopped immediately. The spill kit will be mobilized to contain and neutralize the spill. If necessary, a large amount of water may be used to dilute the $KMnO_4$ to safe levels. The liquid will be recovered, containerized, and disposed of in accordance with applicable federal, state, and local laws. A Site meeting will be held with Cascade to discuss the surfacing occurrence, and what actions can be taken to prevent recurrence. The injection point and surfacing location will be sealed with bentonite before moving to a new injection point. Injection pressures, flow rates, volumes, and/or location may be adjusted to prevent future surfacing.

## 5.5 UTILITY CLEARANCE

Public and private utility locating services will be contracted to clear the ISCO injection and performance boring locations prior to drilling activities. New information pertaining to subsurface utility locations not documented during prior investigation work will be mapped for future reference. Utility locations will be evaluated at CI Plant 4 and the east-adjacent Pacific Food Systems property prior to implementation of the interim action to assess the potential for surfacing and/or dispersion of the oxidant via utility corridors. As-built details will be obtained from CI and Pacific Food Services to assess utility construction materials to evaluate potential susceptibility to damage from $KMnO_4$. According to information provided by Carus Corporation, the 3 percent $KMnO_4$ solution is compatible with construction materials for subsurface utilities such as metal and plastic piping and conduit. Natural rubber is the only material that could be damaged through injection of $KMnO_4$. Drilling locations may be modified during field activities as necessary based on access considerations and the locations of utilities and other features.

## 5.6 BASELINE GROUNDWATER SAMPLING

Prior to initiation of ISCO injection, five semi-permanent 1-inch-diameter observation wells with pre-pack screens (monitoring wells OBW-1 through OBW-5) will be installed in CI Plant 4 using direct-push drilling methods (Figure 5). Baseline groundwater samples will be collected from Water Table Interval monitoring wells MW-6 and MW-7 and the five newly installed monitoring wells. The groundwater sampling will be conducted in general accordance with the standard procedures cited in the Technical Memorandum regarding FINAL West of 4th Groundwater Monitoring Program Plan, 2017 through Draft Cleanup Action Plan, W4 Joint Deliverable, Agreed Order No. DE 10402 dated March 21, 2017, from Ms. Janet Knox of PGG (2017) to Mr. Ed Jones of Ecology, and the attached Sampling And Analysis Plan (SAP) (Appendix C). Quality assurance and quality control will be managed in accordance with the Quality Assurance Project Plan (QAPP) (Appendix D).

The groundwater samples will be submitted to a Washington-accredited laboratory for analysis for:

- CVOCs by EPA Method 8260D. Initial concentrations will be compared to post-injection concentrations as a measure of the effectiveness of the ISCO treatment.
- Dissolved arsenic and total and dissolved chromium, manganese, cadmium, and lead by EPA Method 200.8; total and dissolved iron by EPA Method 6010D; and total and dissolved mercury by EPA Methods 7470A/245.1. ISCO can change the oxidation state of some metals or release metals through oxidation reactions, resulting in mobilization of metals. Baseline measurements of metals at select wells will be used to evaluate whether

mobilization of metals is occurring, and whether mobilization is limited to the treatment zone. Mobilization of metals typically is limited to the zone of oxidation.

- Hexavalent chromium by Standard Method SM3500-CR B. Hexavalent chromium is a potential by-product of oxidation of existing trivalent chromium and is mobile and toxic. Although there is no risk of Site groundwater being used as a potable water source, hexavalent chromium should be monitored to confirm that if formed, it returns to the stable trivalent state outside the treatment zone is necessary. Hexavalent chromium will only be analyzed in the groundwater sample collected from monitoring well MW-7, which is down-gradient of the ISCO treatment zone.
- Total dissolved solids by Standard Method SM2540C. Monitoring will provide data on the effects of ISCO on major cations and the solids that may be generated by ISCO reactions. The baseline condition of groundwater will be compared to conditions observed during subsequent performance monitoring events to evaluate potential oxidant demand, and for generation of solid by-products that may reduce permeability of the soil matrix.

Additional field and geochemical parameters that will be directly measured using field instrumentation during sample collection include turbidity, temperature, pH, dissolved oxygen, oxidation-reduction potential, and specific conductance. These parameters will be compared to future performance monitoring data to evaluate the effects of ISCO and the potential radius of influence (ROI).

## 5.7 INTERIM ACTION APPROACH AND DESIGN

The interim action involves a two-stage approach to oxidant delivery, and was designed based on guidance provided by ITRC (2005). Stage 1 involves injectability testing into five separate locations in CI Plant 4. Stage 2 involves full-scale implementation of ISCO based on the results from the injectability testing conducted during Stage 1. This Work Plan focuses on implementation of the Stage 1 injections.

The scope of work for implementation of the Stage 2 injections will be documented in a draft Stage 2 Field Implementation Work Plan that will be prepared after the Stage 1 injections have been completed and the process and performance monitoring data have been evaluated.

## 5.8 STAGE 1: INJECTABILITY TESTING

Injectability testing is performed to evaluate the data necessary for implementation of a full-scale design. Stage 1 will be conducted to evaluate injection rates, injection pressures, injection volumes, ROI, injection well/point spacing, and oxidant concentrations. Subsurface environments rarely are homogeneous and isotropic, which the injection design must take into account. Injectability testing is performed to understand the variation in ROI and subsurface permeability to enable effective distribution of the oxidant throughout the subsurface. Stage 1 will include the following ISCO injection points, shown on Figure 5:

- ISCO injection points B3, C5, D4, and F5 in the silt with sand layer in the vadose zone from approximately 1 to 8 feet bgs; and
- ISCO injection point E5 from 1 foot bgs in the vadose zone to 20 feet bgs in the Water Table Interval.

These depth intervals were selected to allow evaluation of injection pressure, flow rate, and volume in areas where COC concentrations exceed PCULs in different soil types and/or in the Water Table Interval. These depth intervals also will allow evaluation of ROI in different soil types and under different pressures. The locations were selected because they will not interfere with one another, but will be useful in evaluating potential modifications to the ISCO approach for Stage 2. High-pressure injection points D4 and C5 were chosen because they are a safe distance from subsurface utilities.

Low-pressure injections into two different depth intervals at pressures of 5 pounds per square inch or less will be conducted at injection points B3, E5, and F5 (Figure 5) to evaluate their delivery parameters and ROI. High-pressure injections at pressure ranges of 50 to 100 pounds per square inch will be conducted at injection points D4 and C5 to evaluate delivery parameters and ROI at two depth intervals. Injection points D4 and C5 were specifically chosen in areas away from subsurface utilities to minimize the risk of the oxidant surfacing at higher injection pressures. Concrete packers will be placed around the injection rods to prevent surfacing of the oxidant from the injection borehole. A process flow diagram for the ISCO injections provided by Cascade is included as Appendix E.

Representatives of CI, Farallon, Cascade, and Ecology will hold a meeting at CI Plant 4 on the first day of injection to ensure that all parties are aware of the activities that are planned for the Stage 1 injections, and that questions regarding these activities can be discussed and answered. The three low-pressure injections will be conducted first, followed by the high-pressure injections into injection points D4 and C5. This will allow Farallon and Cascade to assess whether there will be any potential safety issues prior to injecting into injection point C5, proximate to the Pacific Food Systems North Building on the east-adjacent property (Figure 5). The subslab vapor monitoring points used to monitoring the negative-pressure field applied beneath the building slab that were installed as part of the subslab depressurization system for the Pacific Foods Systems North Building will be monitored for pressure changes prior to and throughout the injection process at injection point C-5. The pressure changes before, during, and after the injection process will be evaluated for safety purposes and for the potential influence of the high-pressure injection process at this adjacent property.

Injections will be conducted using a "top down" approach, during which the injection tooling will be advanced to the first treatment interval, and the desired volume of the 3 percent $KMnO_4$ solution will be injected into the formation at the predetermined flow rate and pressure. Upon completion of the injection at that interval, the injection tooling will be advanced to the next interval, and the process will be repeated until the selected injection point has been completed. Injection rates and total flow will be measured using digital turbine flow meters. Various pressure gauges are used by Cascade to monitor injection point pressures.

Although it is possible to evaluate the hydraulic behavior of unconsolidated materials by injecting clean water with direct-push tools, Stage 1 will use a 3 percent $KMnO_4$ solution. According to ITRC (2005), a solution of up to 4 percent concentration is typical for $KMnO_4$ ISCO injection projects. A 3 percent $KMnO_4$ solution will be used for Stage 1 based on the low concentrations of COCs in soil and in groundwater in Water Table Interval groundwater. Oxidation of COCs with $KMnO_4$ requires direct electron transfer, and therefore requires contact between the oxidant and the COC. A 3 percent $KMnO_4$ solution is expected to allow sufficient longevity of the $KMnO_4$ for contact to be made between the oxidant and COCs in soil and in groundwater in the Water Table Interval.

The following equations were used to calculate the effective pore volume and the amount of $KMnO_4$ needed to treat each grid square depicted on Figure 5 (assuming a 14-foot ROI). The calculations below will be adjusted for Stage 2 following evaluation of the Stage 1 results.

Effective Pore Volume Calculation

$$\text{ROI (area in square feet)} \cdot \text{depth interval (feet)} \cdot \text{soil porosity (unitless)} = \text{Volume (feet}^3\text{)}$$

Unit Conversion for Effective Pore Volume Calculation

$$\text{Volume (feet}^3\text{)} \cdot \frac{7.48 \text{ gallons}}{\text{foot}^3} = \text{Volume (gallons)}$$

Total Design Mass of Permanganate per Injection Point

$$\text{MnO}_4 \text{ Demand from COCs (pounds)} + (\text{Effective PNOD [pounds]} \cdot \text{Safety Factor[unitless]}) \\ = \text{Design Mass of KMnO}_4 \text{ (pounds)}$$

The permanganate demand from COCs was estimated using equations based on the soil bulk density, the effective pore volume, the stoichiometric requirement of the COCs, and COC concentrations in soil and groundwater beneath CI Plant 4. The effective permanganate natural oxidant demand is an estimate because there are no Site-specific data. The safety factor is an estimate that takes into consideration contaminant mass estimates and the contact and residence time of the $KMnO_4$ based on seepage velocity derived during the RI. A safety factor of 2 was used in the vadose zone and of 1 in the Water Table Interval.

According to Carus Corporation, 0.25 pound of $KMnO_4$ per 1 gallon of water is needed to generate a 3 percent $KMnO_4$ solution. The following equation was used to calculate the volume of water needed to dilute the total design mass of permanganate per injection point:

Water Volume for 3 Percent Solution

$$\text{Mass of KMnO}_4 \text{ (pounds)} \cdot \frac{1 \text{ gallon}}{0.25 \text{ pounds}} = \text{Water Volume for Solution (gallons)}$$

The following values were used in injection design calculations. Site-specific values from the feasibility study prepared by the West of Fourth Group and PGG (2016) were used whenever possible.

- Effective porosity = 25 percent
- Hydraulic gradient = 0.0012 foot per foot
- Soil bulk density = 1.51 kilogram per liter
- Fraction of organic carbon = 0.2 percent

Using the equations above, the following $KMnO_4$ mass and water volumes were calculated for each injection point.

| Injection point | Depth Interval (feet bgs) | Mass of Potassium Permanganate (pounds) | Volume of Water (gallons) |
|---|---|---|---|
| B3 | 1 to 8 | 948 | 3,792 |
| D4 | 1 to 8 | 948 | 3,792 |
| C5 | 1 to 8 | 948 | 3,792 |
| F5 | 1 to 8 | 948 | 3,792 |
| E5 | 1 to 20 | 1,761 | 7,044 |

Vadose zone injections will be conducted using a 2-foot screen; injections into the Water Table Interval will be conducted using a 5-foot screen. Concrete packers will be placed around the tooling above and below the screen to minimize the possibility of surfacing from the borehole. Flow rates are expected to range from approximately 1 gallon per minute for low-pressure injection points B3, E5, and F5, to 20 gallons per minute for high-pressure injection points D4 and C5, based on other injection projects conducted by Cascade in the general vicinity of the Site. The minimum pressure typically is applied to achieve flow of the injected solution into the formation. Pressure is gradually increased, and the resulting increase in the flow rate is observed to determine the optimum injection pressure and flow rate to maximize distribution of the $KMnO_4$ solution. Injection pressures must be balanced to avoid over-pressurizing the formation, which can lead to surfacing. Each temporary injection point is equipped with a pressure gauge and relief valve, and is controlled by an injection manifold equipped with a pressure regulator and a system pressure-relief valve. Each individual injection line has a pressure gauge and flow meter. As pressure is applied to each injection point, the pressure at the injection boring and manifold is observed, to monitor the permeability of the formation, and to ensure there is no pressure buildup where more pressure than the formation can accommodate is being applied. If the pressure at the injection boring exceeds the pressure at the injection manifold, the pressure at the injection boring will be decreased to allow the formation to equilibrate to prevent surfacing.

When injection has been completed, each injection boring will be backfilled with bentonite grout to approximately 1 foot from the ground surface to mitigate settling, and patched with concrete or asphalt at the ground surface to match the surface material and existing grade. The bentonite grout will mitigate the potential for preferential pathways and surfacing in future ISCO injections.

The Stage 1 ISCO injections will be monitored and evaluated in accordance with the process and performance monitoring program described below.

## 5.9 PROCESS AND PERFORMANCE MONITORING

Process and performance monitoring is conducted frequently during the most-active phase of remediation to evaluate the distribution of the oxidant, and to monitor migration of solubilized metals, and destruction versus migration of COCs. Process monitoring is conducted as a quality control measure before, during, and immediately after the injection operation. Objectives of process monitoring for the Stage 1 injections include confirmation of oxidant injection concentrations, volumes, flow rates, and pressures; and of the ROI of the injection. Performance monitoring includes establishing baseline conditions (see Section 5.6, Baseline Groundwater Sampling) at a site prior to remediation, and measuring the contaminant reduction, by-products of the ISCO reaction, and changes in groundwater geochemistry. The following sections describe the monitoring for Stage 1.

Stage 1 will be conducted to evaluate injection rates, pressures, and volumes; ROI; injection spacing; and oxidant longevity and concentration. Process monitoring will include documenting injection rates, pressures, and volumes during each of the five Stage 1 injections. Sudden changes in injection rates and pressure usually are the first signs of surfacing during pressurized ISCO injection. If oxidant surfaces, injection will be stopped immediately. The injection contractor will immediately contain and neutralize oxidant that surfaces.

Subslab pressure at the Pacific Food Systems North Building will be monitored during high-pressure ISCO injection at injection point C5 using the subslab monitoring ports that were installed as part of the subslab depressurization system at the Pacific Food Systems North Building. Prior to injection at ISCO injection point C5, the subslab depressurization system will be turned off, and the subsurface will be allowed to equilibrate for at least 30 minutes before baseline subslab pressure measurements are obtained at subslab monitoring ports SSMP-1 and SSMP-3 (Figure 5). Subslab pressure will be monitored every 30 to 60 minutes, depending on back pressure observations at the injection point. High back pressures will require more-frequent monitoring, and will be assessed in the field based on process monitoring at the injection point. Subslab pressures will be monitored using a low-range Dwyer magnehelic gauge with a range of 0 to 2 inches of water. The pressure data and other process-monitoring data will be used to evaluate the injection radius of influence, and potential safety concerns associated with higher-pressure injection work.

Evaluation of the ROI, oxidant longevity, and oxidant concentration will be conducted as follows. Three continuous cored performance borings will be drilled around each Stage 1 ISCO injection point (a total of 15 performance borings) at various distances and directions from the injection point to evaluate the distribution of $KMnO_4$. Performance borings will be advanced the same day or the day following the Stage 1 ISCO injections. These performance borings will be advanced at distances of 5 feet north, 10 feet southeast, and 15 feet southwest of each Stage 1 ISCO injection point to a total depth a maximum of 2 feet deeper than the ISCO injection point to assess the actual injection radius of each pilot test injection point and the distribution of the $KMnO_4$ in the soil matrix. Each of the borings will be inspected for color. $KMnO_4$ will cause the soil to exhibit a purple to pink hue based on distribution and concentration, which becomes black as the soil is exposed to air. The color distribution and detailed lithology of each boring will be logged by a Farallon Field Geologist on a boring log, with depth noted, and photographed to document the distribution and to estimate the concentration of KMnO4 based on visual observations. A minimum of one soil sample per 5-foot depth interval exhibiting a pink or purple hue will be collected and submitted for analysis for $KMnO_4$ by Standard Method SM4500 to determine the concentration of $KMnO_4$ in the soil. Additional soil samples may be analyzed based on observations of soil conditions at the time of drilling. Conditions that may warrant analysis of additional samples may include extreme differences in coloration within a sampling interval that would suggest the potential for a less-uniform oxidant demand or a distribution pattern related to the soil matrix composition. The data will be used collectively to evaluate oxidant demand and distribution potential beneath CI Plant 4, to allow for a more-effective Stage 2 injection program regarding dosing and distributing the oxidant. If $KMnO_4$ is not observed in a Stage 1 performance boring, one soil sample will be collected from each soil type and analyzed for $KMnO_4$ natural oxidant demand analysis by ASTM International Method D7262-10, Test Method A (Appendix F). These data will be used to evaluate competing oxidant demands from natural materials in the soil. Each boring will be sealed with bentonite to within 1 foot of the ground surface, and capped with concrete or asphalt to match the existing surface.

Groundwater will be visually inspected for color at observation wells OBW-3 and OBW-5 and monitoring wells MW-6 and MW-7 during and immediately following injection. The color will be compared to the color chart correlating color with $KMnO_4$ concentration in the RemOx Desk Reference provided in Appendix G. Standard spectrophotometric methods using the Hach DR 890 will be used to measure $KMnO_4$ concentrations (Appendix H). The concentration and color will be logged to document the distribution and concentration of $KMnO_4$ injected into the formation. If evidence of $KMnO_4$ is identified following injection, the wells will be monitored daily for 1 week following the injection period to evaluate the rate at which the oxidant is expended. If $KMnO_4$ persists after the first week of monitoring, the frequency of monitoring will become weekly for up to 4 weeks, and the rate of degradation will continue to be evaluated. If $KMnO_4$ persists without significant reduction, the performance monitoring borings described below will be completed to evaluate soil conditions. If $KMnO_4$ is expended, groundwater samples will be collected from observation wells OBW-3 and OBW-5 and monitoring well MW-6. The sampling and analysis will be conducted as described in Section 5.6, Baseline Groundwater Sampling. If there is no evidence of permanganate in groundwater at monitoring well MW-7, a groundwater sample will be collected for analysis for hexavalent chromium to assess the potential formation and mobilization of this oxidation by-product. If groundwater samples are collected and analyzed for CVOCs and/or metals, the samples will be "quenched" through application of ascorbic acid. The "quenching" process neutralizes residual oxidant present in the sample so reactions do not continue between the time of sample collection and analysis by the laboratory.

Four weeks following advancement of the first series of performance borings described above, a second series of performance monitoring borings will be advanced proximate to the initial set of borings to evaluate changes in parameters collected and noted above. This schedule may be accelerated if $KMnO_4$ is observed in the observation wells cited above, and the monitoring conducted indicates that $KMnO_4$ is expended prior to 4 weeks.

Each of the second series of performance monitoring borings will be inspected for color. The color distribution and detailed lithology of each boring will be recorded by a Farallon Field Geologist on a boring log, with depth noted, and photographed to document the distribution and to estimate the changes in the concentrations of $KMnO_4$ based on visual observations. A minimum of one soil sample per 5-foot depth interval exhibiting a pink or purple hue will be collected and submitted for analysis for $KMnO_4$ by Standard Method SM4500. The results will be compared to the initial performance sampling results. When field observations indicate that the oxidant has been expended, performance soil samples will be collected at depths where previous sampling indicated COCs were detected. The samples will be submitted to the analytical laboratory for analysis for CVOCs by EPA Method 8260C to assess the reduction in COC concentrations as a result of chemical oxidation.

The results will be used to evaluate whether the initial 3 percent concentration of $KMnO_4$ is sufficient to overcome the natural oxidant demand of the soil matrix and reduce COC concentrations to less than PCULs. These data will be used to adjust the spacing between injection points and the vertical injection volume for subsequent injection points, and possibly the method of ISCO delivery, to maximize distribution in the soil matrix.

The analytical results for the soil and groundwater samples will be compared to historical analytical results for co-located soil and groundwater samples to evaluate rebounding. Any necessary adjustments in design spacing and the number of Stage 2 injection points will be documented in a Stage 2 Field Implementation Work Plan, and submitted to Ecology for approval prior to implementation of Stage 2 injections.

# 6.0 INTERIM ACTION DOCUMENTATION

This section summarizes the interim action documents that will be prepared during the interim action activities.

## 6.1 PROJECT DOCUMENTS AND REPORTING

### 6.1.1 Revised Stage 1 Field Implementation Work Plan

This Work Plan provides details regarding implementation of Stage 1 of the interim action, including the initial ISCO injection points, initial ISCO injection design criteria, performance monitoring details, criteria for evaluating the effectiveness of Stage 1 of the interim action, and reporting requirements based on comments from Ecology regarding the Interim Action Work Plan. This Work Plan also includes the following supporting documents.

#### 6.1.1.1 Health and Safety Plan

A draft HASP (Appendix A) for the field activities was prepared in accordance with Section 810 of Chapter 173-340 of the Washington Administrative Code. The HASP complies with the requirements of the Occupational Safety and Health Act of 1970 and the Washington Industrial Safety and Health Act (Chapter 49.17 of the Revised Code of Washington).

#### 6.1.1.2 Sampling and Analysis Plan

A SAP (Appendix C) was prepared to guide the sampling efforts associated with Stage 1 of the interim action. The SAP includes a discussion of sampling locations, frequency, and analytical parameters. The SAP contains standard operating procedures related to the specific field tasks that will be performed during the interim action. These standard operating procedures include field sampling and documentation, soil sampling, groundwater sampling, and waste management.

#### 6.1.1.3 Quality Assurance Project Plan

A QAPP (Appendix D) was prepared to assess the quality and reproducibility of analytical data generated in association with Stage 1 of the interim action. The QAPP discusses quality assurance/quality control samples that will be collected to support the interim action.

### 6.1.2 Quarterly Status Reports

Quarterly status reports will be submitted to Ecology in the standard Quarterly Progress Reports prepared by CI. The Quarterly Progress Reports will include a summary of the interim action activities conducted. If necessary, more-frequent progress reporting will occur via email messages and/or meetings with Ecology to refine the scope of work based on performance monitoring data for the interim action.

### 6.1.3 Stage 2 Field Implementation Work Plan

When the Stage 1 injections and the evaluation of associated process and performance monitoring data have been completed, a Stage 2 Field Implementation Work Plan will be prepared. The Stage 2 Field Implementation Work Plan will include a summary and evaluation of the Stage 1 injections, and will incorporate lessons learned into the design and implementation details for the full Stage 2 implementation of ISCO at CI Plant 4.

# 7.0 SCHEDULE AND REPORTING

This section summarizes the schedule for implementation of Stage 1 of the interim action and associated reporting deliverables that will be prepared. The anticipated interim action schedule is presented as a timeline in Appendix I. The milestones associated with implementation of Stage 1 of the interim action and the potential schedule to achieve those milestones are provided below.

| **Submittal of Deliverable** | **Completed or Anticipated Schedule** |
|---|---|
| Draft Interim Action Work Plan | Completed Week of July 24, 2017 |
| Final Interim Action Work Plan | Completed December 22, 2017 |
| Draft Field Implementation Work Plan | Completed March 8, 2018 |
| Revised Capital Industries Plant 4 Stage 1 Field Implementation Work Plan | Within 30 days of receipt of Ecology's comments regarding Draft Field Implementation Work Plan |
| Stage 2 Capital Industries Plant 4 Field Implementation Work Plan Addendum | Within 45 days of evaluation of Stage 1 injection data |
| Quarterly Progress Reports | Each quarter during and following implementation of the interim action |

| **Field Work** | **Anticipated Schedule** |
|---|---|
| Obtain UIC Permit | Upon Ecology approval of Final Interim Action Work Plan |
| Installation and development of five semi-permanent 1-inch-diameter monitoring wells | Approximately 2 weeks prior to baseline groundwater monitoring event |
| Baseline groundwater monitoring event | Within 2 weeks prior to Stage 1 ISCO injections |

| | |
|---|---|
| Stage 1 ISCO injections | To be scheduled upon Ecology approval of Revised Capital Industries Plant 4 Stage 1 Field Implementation Work Plan, receipt of UIC permit, and review of data from baseline groundwater monitoring event |
| Stage 1 performance monitoring | First-round Stage 1 performance borings to be advanced immediately following Stage 1 ISCO injections for visual observation of ISCO injection radius.<br>Performance groundwater monitoring to be conducted 2 weeks after Stage 1 injection to observe distribution of $KMnO_4$, and collect groundwater samples if oxidant has been expended.<br>Second-round performance borings to be advanced 4 weeks after Stage 1 injection for visual observation of persistence of $KMnO_4$, and assessment of CVOC concentrations in soil proximate to Stage 1 injection points if $KMnO_4$ has been expended. This schedule will be modified accordingly if evidence of $KMnO_4$ persists. |

# 8.0 REFERENCES

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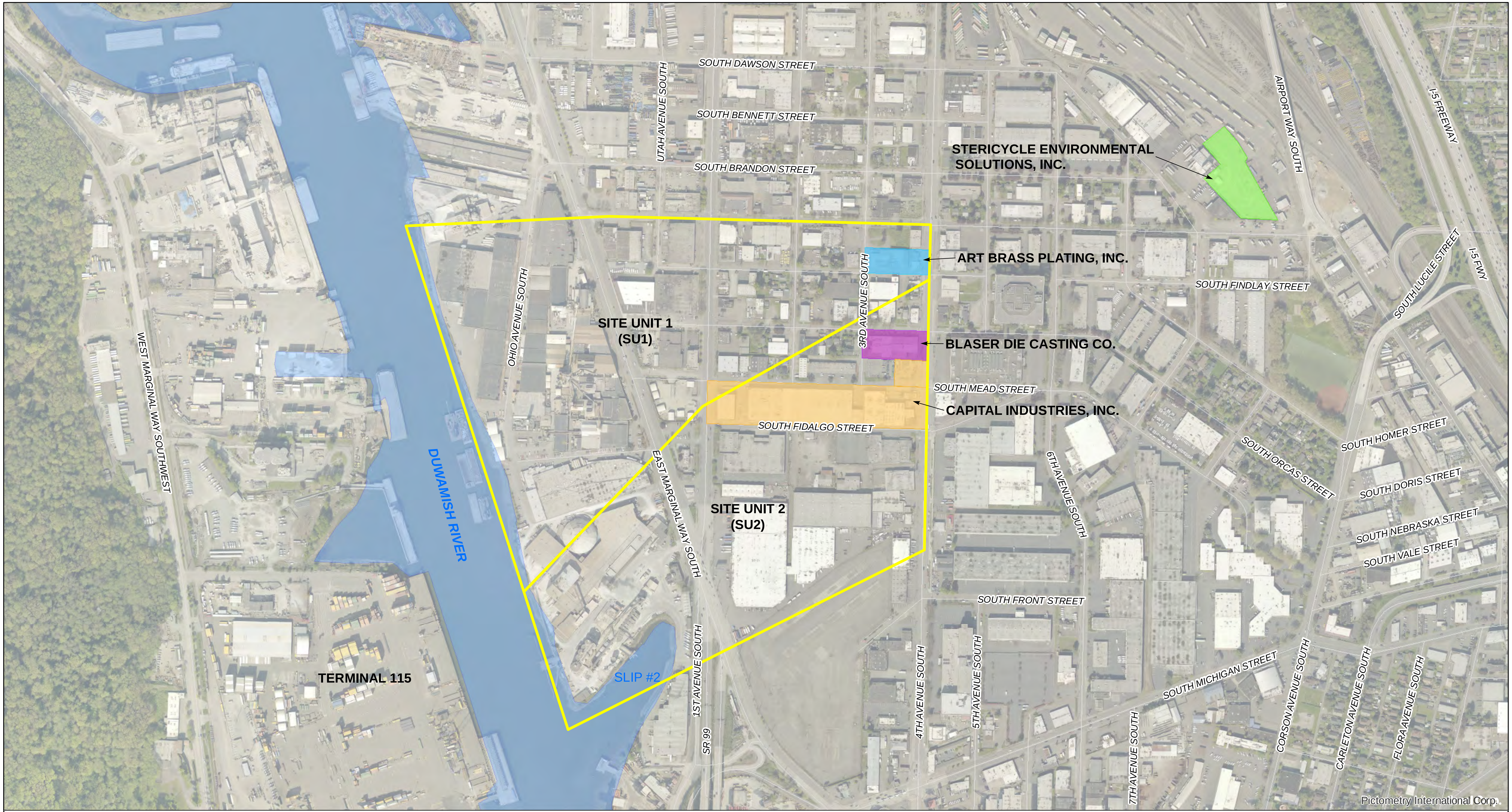
# FIGURES

REVISED CAPITAL INDUSTRIES PLANT 4 STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008



LEGEND

🟦 ART BRASS PLATING, INC.
🟪 BLASER DIE CASTING CO.
🟧 CAPITAL INDUSTRIES, INC.
🟩 STERICYCLE ENVIRONMENTAL SOLUTIONS, INC.
▭ SITE UNIT BOUNDARY

N

0 250 500
SCALE IN FEET

FARALLON CONSULTING

Washington
Issaquah | Bellingham | Seattle

Oregon
Portland | Bend | Baker City

California
Oakland | Folsom | Irvine

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# FIGURE 1

SITE DIAGRAM
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5801 3RD AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: tperrin
Checked By: JK
Date: 5/7/2018
Disc Reference:
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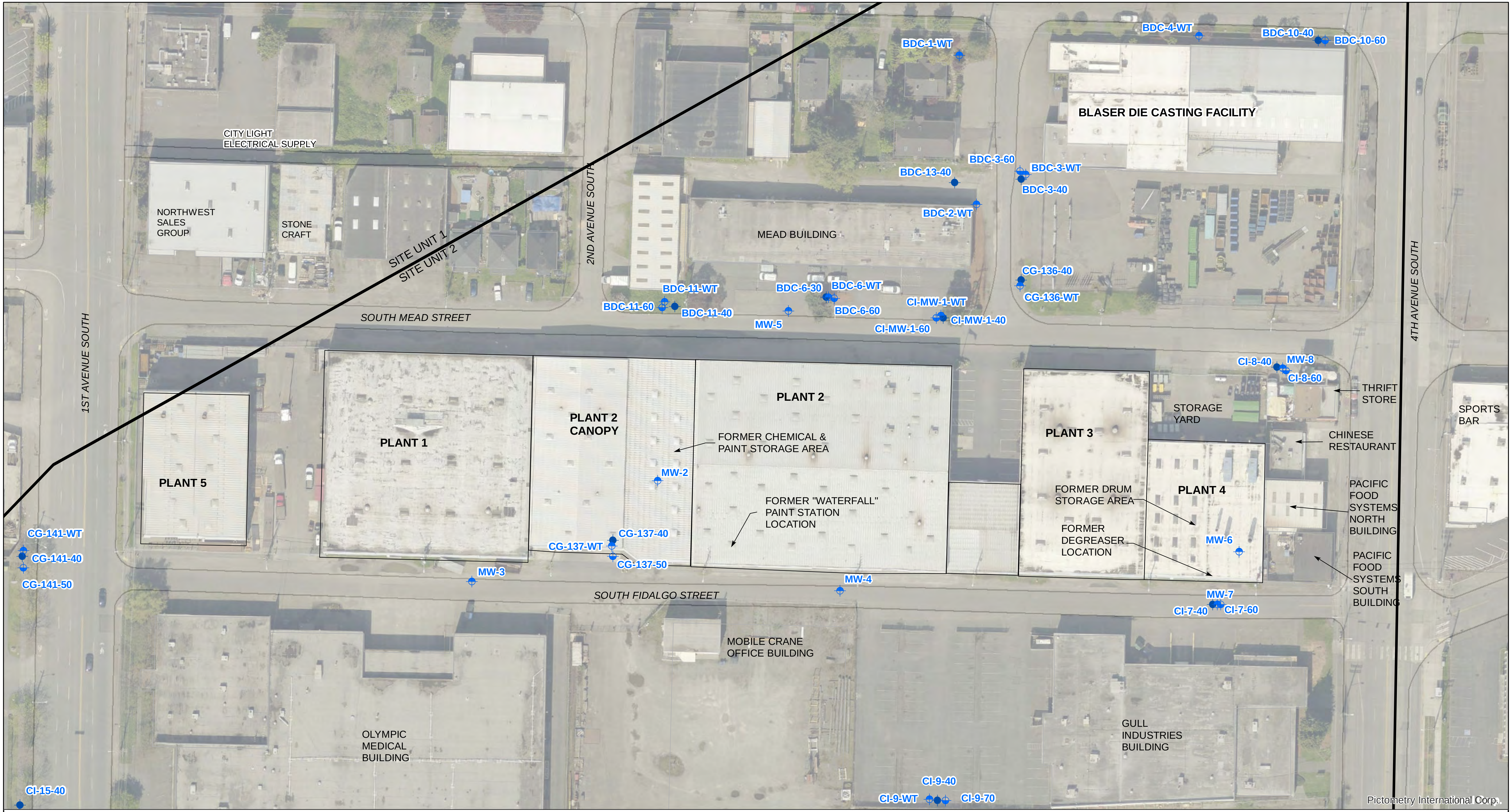

LEGEND

| | |
|---|---|
| ⌖ | WATER TABLE INTERVAL MONITORING WELL |
| ● | SHALLOW INTERVAL MONITORING WELL |
| ⌖ | INTERMEDIATE INTERVAL MONITORING WELL |
| ▭ | SITE UNIT BOUNDARY |
| ▭ | BUILDINGS |

N

0 40 80
SCALE IN FEET

FARALLON CONSULTING

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Oregon
Portland | Bend | Baker City

California
Oakland | Folsom | Irvine

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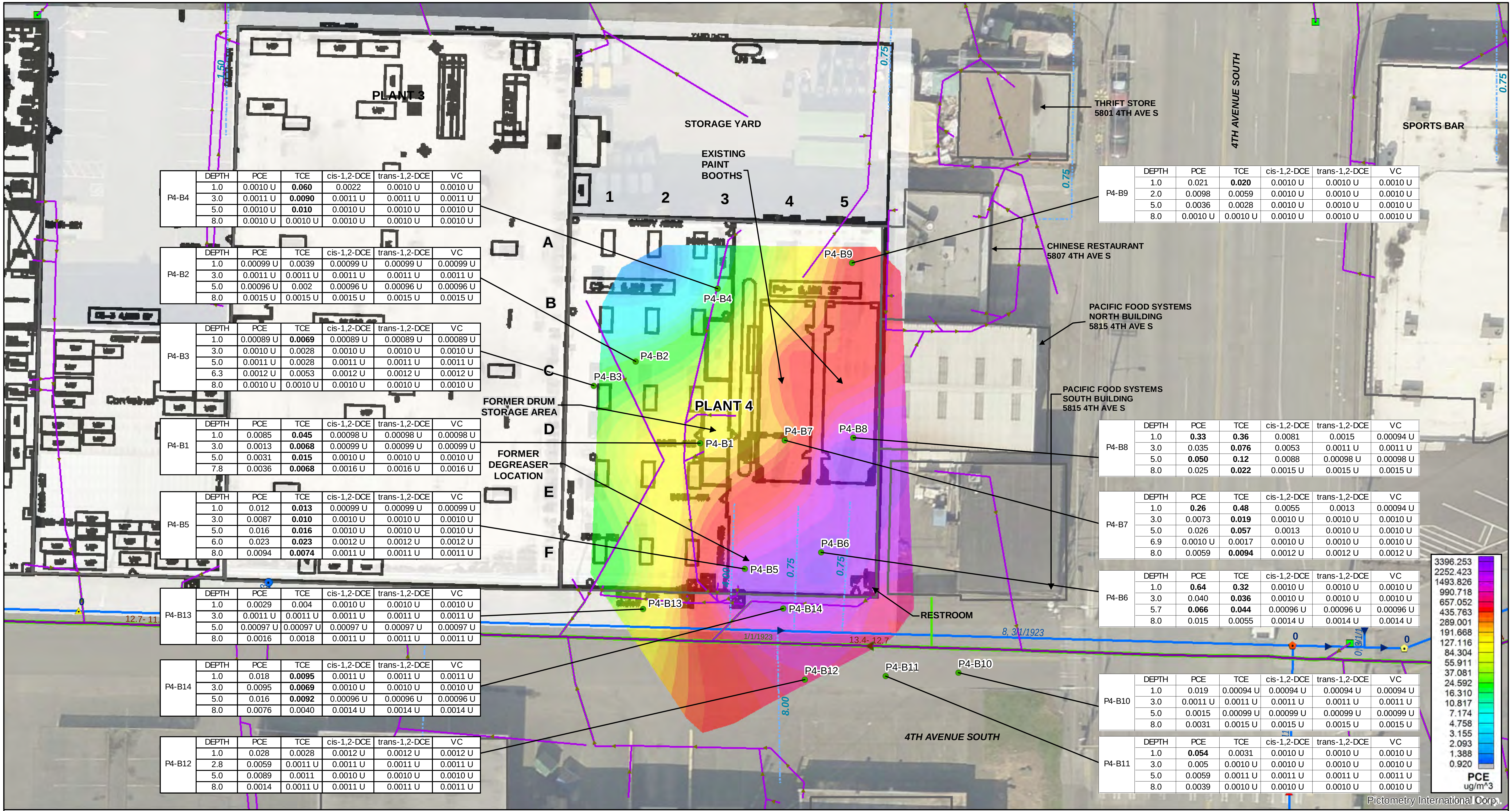
# FIGURE 2

## PROPERTY DIAGRAM
## WEST OF 4TH GROUP SITE
## CAPITAL INDUSTRIES, INC.
## 5801 3RD AVENUE SOUTH
## SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: tperrin
Checked By: JK
Date: 5/7/2018
Disc Reference:
Document Path: Q:\Projects\457 CapitalIndust\008 PilotStudy\InterimWorkPlan\Revision_20180507\Figure2_PropertyDiagram.mxd



| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B4 | 1.0 | 0.0010 U | **0.060** | 0.0022 | 0.0010 U | 0.0010 U |
| | 3.0 | 0.0011 U | **0.0090** | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.0010 U | **0.010** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 8.0 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B2 | 1.0 | 0.00099 U | 0.0039 | 0.00099 U | 0.00099 U | 0.00099 U |
| | 3.0 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.00096 U | 0.002 | 0.00096 U | 0.00096 U | 0.00096 U |
| | 8.0 | 0.0015 U | 0.0015 U | 0.0015 U | 0.0015 U | 0.0015 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B3 | 1.0 | 0.00089 U | **0.0069** | 0.00089 U | 0.00089 U | 0.00089 U |
| | 3.0 | 0.0010 U | 0.0028 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.0011 U | 0.0028 | 0.0011 U | 0.0011 U | 0.0011 U |
| | 6.3 | 0.0012 U | 0.0053 | 0.0012 U | 0.0012 U | 0.0012 U |
| | 8.0 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B1 | 1.0 | 0.0085 | **0.045** | 0.00098 U | 0.00098 U | 0.00098 U |
| | 3.0 | 0.0013 | **0.0068** | 0.00099 U | 0.00099 U | 0.00099 U |
| | 5.0 | 0.0031 | **0.015** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 7.8 | 0.0036 | **0.0068** | 0.0016 U | 0.0016 U | 0.0016 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B5 | 1.0 | 0.012 | **0.013** | 0.00099 U | 0.00099 U | 0.00099 U |
| | 3.0 | 0.0087 | **0.010** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.016 | **0.016** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 6.0 | 0.023 | **0.023** | 0.0012 U | 0.0012 U | 0.0012 U |
| | 8.0 | 0.0094 | **0.0074** | 0.0011 U | 0.0011 U | 0.0011 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B13 | 1.0 | 0.0029 | 0.004 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 3.0 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.00097 U | 0.00097 U | 0.00097 U | 0.00097 U | 0.00097 U |
| | 8.0 | 0.0016 | 0.0018 | 0.0011 U | 0.0011 U | 0.0011 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B14 | 1.0 | 0.018 | **0.0095** | 0.0011 U | 0.0011 U | 0.0011 U |
| | 3.0 | 0.0095 | **0.0069** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.016 | **0.0092** | 0.00096 U | 0.00096 U | 0.00096 U |
| | 8.0 | 0.0076 | 0.0040 | 0.0014 U | 0.0014 U | 0.0014 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B12 | 1.0 | 0.028 | 0.0028 | 0.0012 U | 0.0012 U | 0.0012 U |
| | 2.8 | 0.0059 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.0089 | 0.0011 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 8.0 | 0.0014 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B9 | 1.0 | 0.021 | **0.020** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 2.0 | 0.0098 | 0.0059 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.0036 | 0.0028 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 8.0 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B8 | 1.0 | **0.33** | **0.36** | 0.0081 | 0.0015 | 0.00094 U |
| | 3.0 | 0.035 | **0.076** | 0.0053 | 0.0011 U | 0.0011 U |
| | 5.0 | **0.050** | **0.12** | 0.0088 | 0.00098 U | 0.00098 U |
| | 8.0 | 0.025 | **0.022** | 0.0015 U | 0.0015 U | 0.0015 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B7 | 1.0 | **0.26** | **0.48** | 0.0055 | 0.0013 | 0.00094 U |
| | 3.0 | 0.0073 | **0.019** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.026 | **0.057** | 0.0013 | 0.0010 U | 0.0010 U |
| | 6.9 | 0.0010 U | 0.0017 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 8.0 | 0.0059 | **0.0094** | 0.0012 U | 0.0012 U | 0.0012 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B6 | 1.0 | **0.64** | **0.32** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 3.0 | 0.040 | **0.036** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.7 | **0.066** | **0.044** | 0.00096 U | 0.00096 U | 0.00096 U |
| | 8.0 | 0.015 | 0.0055 | 0.0014 U | 0.0014 U | 0.0014 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B10 | 1.0 | 0.019 | 0.00094 U | 0.00094 U | 0.00094 U | 0.00094 U |
| | 3.0 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.0015 | 0.00099 U | 0.00099 U | 0.00099 U | 0.00099 U |
| | 8.0 | 0.0031 | 0.0015 U | 0.0015 U | 0.0015 U | 0.0015 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B11 | 1.0 | **0.054** | 0.0031 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 3.0 | 0.005 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.0059 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 8.0 | 0.0039 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |

## LEGEND

● DIRECT-PUSH SOIL BORINGS

→ STORMWATER MAINLINE (WITH INSTALL DATE AND FLOW DIRECTIONS)

→ SANITARY SEWER MAIN LINE AND FLOW DIRECTION

→ WATER MAIN LINE

🟩 STORMWATER CATCH BASIN

● HYDRANT

● SANITARY SEWER MANHOLE

SOIL RESULTS ARE IN MILLIGRAMS PER KILOGRAM

**BOLD** = INDICATES CONCENTRATIONS EXCEED WEST OF FOURTH GROUP SOIL INVESTIGATION PRELIMINARY CLEANUP LEVELS
U = INDICATES CONCENTRATIONS NOT DETECTED ABOVE THE STATED LABORATORY PRACTICAL QUANTITATION LIMIT
PCE = TETRACHLOROETHENE
TCE = TRICHLOROETHENE
cis-1,2-DCE = CIS-1,2-DICHLOROETHENE
trans-1,2-DCE = TRANS-1,2-DICHLOROETHENE
VC = VINYL CHLORIDE

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Quality Service for Environmental Solutions | farallonconsulting.com

Washington
Issaquah | Bellingham | Seattle
Oregon
Portland | Bend | Baker City
California
Oakland | Folsom | Irvine

# FIGURE 3A

PLANT 4 SOIL ANALYTICAL RESULTS AND TETRACHLOROETHENE SOIL GAS RESULTS
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5801 3RD AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: tperrin
Checked By: JK
Date: 5/7/2018
Disc Reference:
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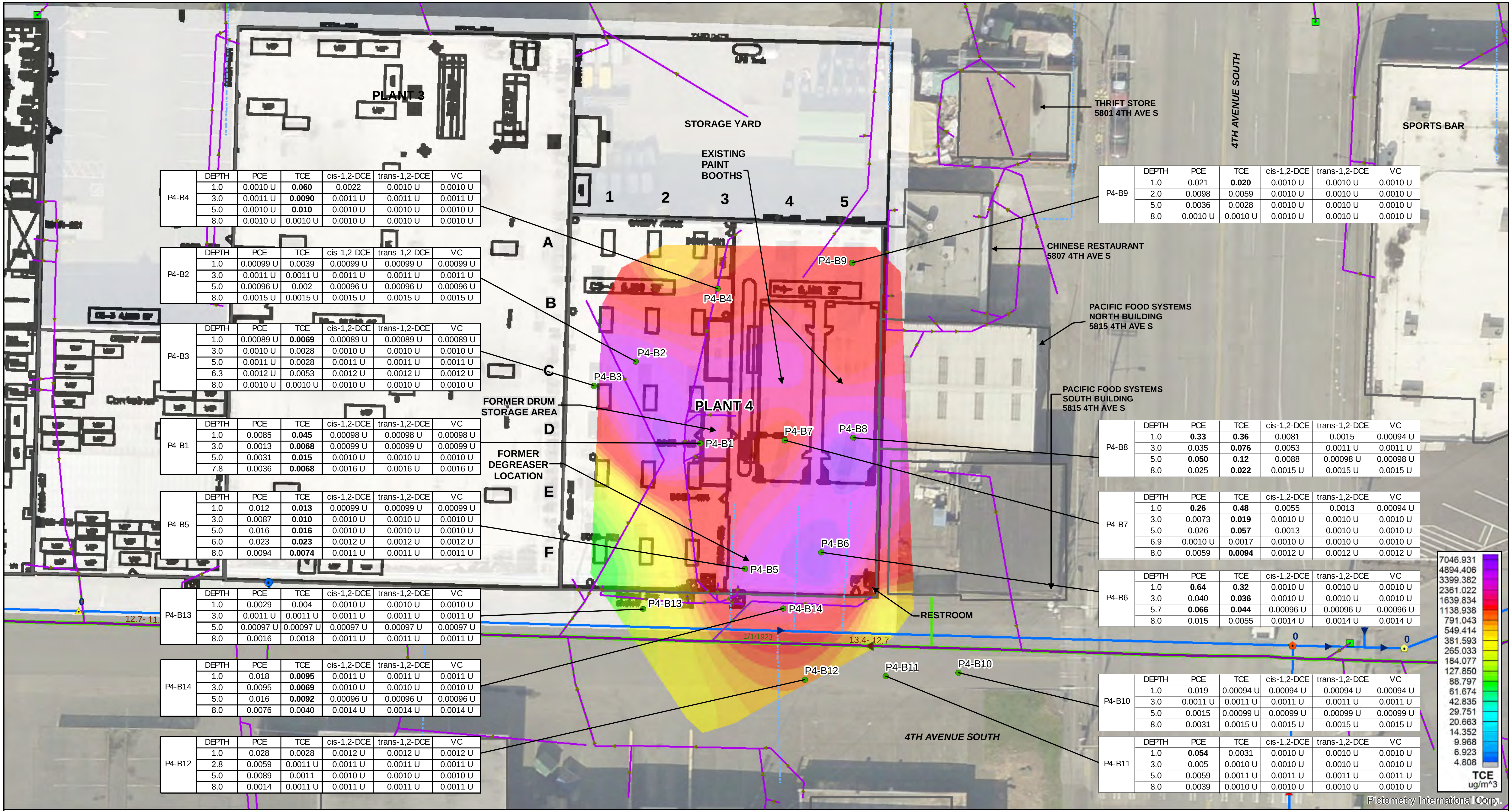

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B4 | 1.0 | 0.0010 U | **0.060** | 0.0022 | 0.0010 U | 0.0010 U |
| | 3.0 | 0.0011 U | **0.0090** | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.0010 U | **0.010** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 8.0 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B2 | 1.0 | 0.00099 U | 0.0039 | 0.00099 U | 0.00099 U | 0.00099 U |
| | 3.0 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.00096 U | 0.002 | 0.00096 U | 0.00096 U | 0.00096 U |
| | 8.0 | 0.0015 U | 0.0015 U | 0.0015 U | 0.0015 U | 0.0015 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B3 | 1.0 | 0.00089 U | **0.0069** | 0.00089 U | 0.00089 U | 0.00089 U |
| | 3.0 | 0.0010 U | 0.0028 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.0011 U | 0.0028 | 0.0011 U | 0.0011 U | 0.0011 U |
| | 6.3 | 0.0012 U | 0.0053 | 0.0012 U | 0.0012 U | 0.0012 U |
| | 8.0 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B1 | 1.0 | 0.0085 | **0.045** | 0.00098 U | 0.00098 U | 0.00098 U |
| | 3.0 | 0.0013 | **0.0068** | 0.00099 U | 0.00099 U | 0.00099 U |
| | 5.0 | 0.0031 | **0.015** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 7.8 | 0.0036 | **0.0068** | 0.0016 U | 0.0016 U | 0.0016 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B5 | 1.0 | 0.012 | **0.013** | 0.00099 U | 0.00099 U | 0.00099 U |
| | 3.0 | 0.0087 | **0.010** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.016 | **0.016** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 6.0 | 0.023 | **0.023** | 0.0012 U | 0.0012 U | 0.0012 U |
| | 8.0 | 0.0094 | **0.0074** | 0.0011 U | 0.0011 U | 0.0011 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B13 | 1.0 | 0.0029 | 0.004 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 3.0 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.00097 U | 0.00097 U | 0.00097 U | 0.00097 U | 0.00097 U |
| | 8.0 | 0.0016 | 0.0018 | 0.0011 U | 0.0011 U | 0.0011 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B14 | 1.0 | 0.018 | **0.0095** | 0.0011 U | 0.0011 U | 0.0011 U |
| | 3.0 | 0.0095 | **0.0069** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.016 | **0.0092** | 0.00096 U | 0.00096 U | 0.00096 U |
| | 8.0 | 0.0076 | 0.0040 | 0.0014 U | 0.0014 U | 0.0014 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B12 | 1.0 | 0.028 | 0.0028 | 0.0012 U | 0.0012 U | 0.0012 U |
| | 2.8 | 0.0059 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.0089 | 0.0011 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 8.0 | 0.0014 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B9 | 1.0 | 0.021 | **0.020** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 2.0 | 0.0098 | 0.0059 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.0036 | 0.0028 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 8.0 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B8 | 1.0 | **0.33** | **0.36** | 0.0081 | 0.0015 | 0.00094 U |
| | 3.0 | 0.035 | **0.076** | 0.0053 | 0.0011 U | 0.0011 U |
| | 5.0 | **0.050** | **0.12** | 0.0088 | 0.00098 U | 0.00098 U |
| | 8.0 | 0.025 | **0.022** | 0.0015 U | 0.0015 U | 0.0015 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B7 | 1.0 | **0.26** | **0.48** | 0.0055 | 0.0013 | 0.00094 U |
| | 3.0 | 0.0073 | **0.019** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.026 | **0.057** | 0.0013 | 0.0010 U | 0.0010 U |
| | 6.9 | 0.0010 U | 0.0017 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 8.0 | 0.0059 | **0.0094** | 0.0012 U | 0.0012 U | 0.0012 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B6 | 1.0 | **0.64** | **0.32** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 3.0 | 0.040 | **0.036** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.7 | **0.066** | **0.044** | 0.00096 U | 0.00096 U | 0.00096 U |
| | 8.0 | 0.015 | 0.0055 | 0.0014 U | 0.0014 U | 0.0014 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B10 | 1.0 | 0.019 | 0.00094 U | 0.00094 U | 0.00094 U | 0.00094 U |
| | 3.0 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.0015 | 0.00099 U | 0.00099 U | 0.00099 U | 0.00099 U |
| | 8.0 | 0.0031 | 0.0015 U | 0.0015 U | 0.0015 U | 0.0015 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B11 | 1.0 | **0.054** | 0.0031 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 3.0 | 0.005 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.0059 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 8.0 | 0.0039 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |

## LEGEND

| | |
|---|---|
| ● | DIRECT-PUSH SOIL BORINGS |
| ▶ | STORMWATER MAINLINE (WITH INSTALL DATE AND FLOW DIRECTIONS) |
| ▶ | SANITARY SEWER MAIN LINE AND FLOW DIRECTION |
| ▶ | WATER MAIN LINE |
| 🟩 | STORMWATER CATCH BASIN |
| ● | HYDRANT |
| ● | SANITARY SEWER MANHOLE |

SOIL RESULTS ARE IN MILLIGRAMS PER KILOGRAM

**BOLD** = INDICATES CONCENTRATIONS EXCEED WEST OF FOURTH GROUP SOIL INVESTIGATION PRELIMINARY CLEANUP LEVELS
U = INDICATES CONCENTRATIONS NOT DETECTED ABOVE THE STATED LABORATORY PRACTICAL QUANTITATION LIMIT
PCE = TETRACHLOROETHENE
TCE = TRICHLOROETHENE
cis-1,2-DCE = CIS-1,2-DICHLOROETHENE
trans-1,2-DCE = TRANS-1,2-DICHLOROETHENE
VC = VINYL CHLORIDE

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# FIGURE 3B

## PLANT 4 SOIL ANALYTICAL RESULTS AND TRICHLOROETHENE SOIL GAS RESULTS
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5801 3RD AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: tperrin
Checked By: JK
Date: 5/7/2018
Disc Reference:
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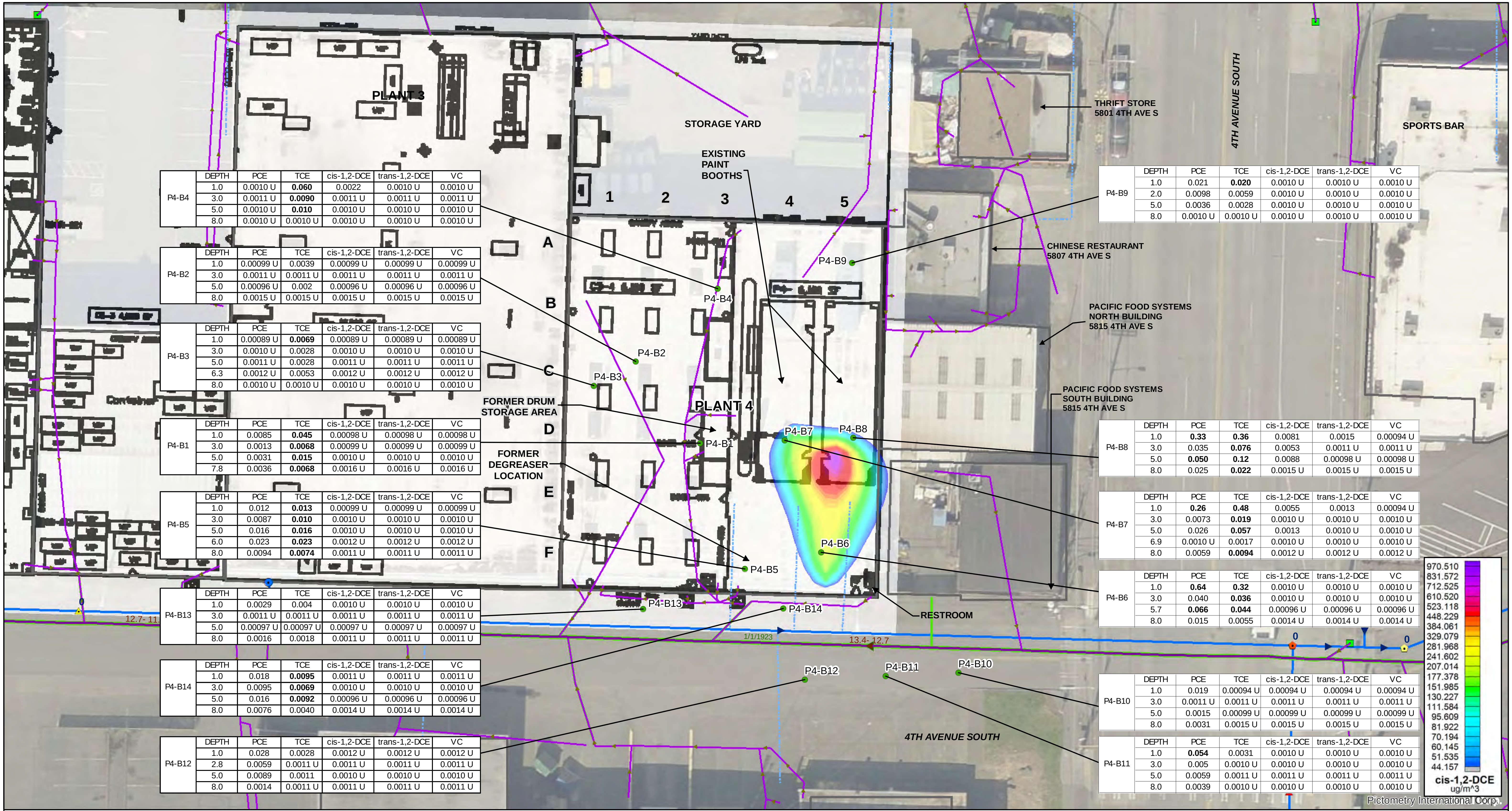

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B4 | 1.0 | 0.0010 U | **0.060** | 0.0022 | 0.0010 U | 0.0010 U |
| | 3.0 | 0.0011 U | **0.0090** | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.0010 U | **0.010** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 8.0 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B2 | 1.0 | 0.00099 U | 0.0039 | 0.00099 U | 0.00099 U | 0.00099 U |
| | 3.0 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.00096 U | 0.002 | 0.00096 U | 0.00096 U | 0.00096 U |
| | 8.0 | 0.0015 U | 0.0015 U | 0.0015 U | 0.0015 U | 0.0015 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B3 | 1.0 | 0.00089 U | **0.0069** | 0.00089 U | 0.00089 U | 0.00089 U |
| | 3.0 | 0.0010 U | 0.0028 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.0011 U | 0.0028 | 0.0011 U | 0.0011 U | 0.0011 U |
| | 6.3 | 0.0012 U | 0.0053 | 0.0012 U | 0.0012 U | 0.0012 U |
| | 8.0 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B1 | 1.0 | 0.0085 | **0.045** | 0.00098 U | 0.00098 U | 0.00098 U |
| | 3.0 | 0.0013 | **0.0068** | 0.00099 U | 0.00099 U | 0.00099 U |
| | 5.0 | 0.0031 | **0.015** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 7.8 | 0.0036 | **0.0068** | 0.0016 U | 0.0016 U | 0.0016 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B5 | 1.0 | 0.012 | **0.013** | 0.00099 U | 0.00099 U | 0.00099 U |
| | 3.0 | 0.0087 | **0.010** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.016 | **0.016** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 6.0 | 0.023 | **0.023** | 0.0012 U | 0.0012 U | 0.0012 U |
| | 8.0 | 0.0094 | **0.0074** | 0.0011 U | 0.0011 U | 0.0011 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B13 | 1.0 | 0.0029 | 0.004 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 3.0 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.00097 U | 0.00097 U | 0.00097 U | 0.00097 U | 0.00097 U |
| | 8.0 | 0.0016 | 0.0018 | 0.0011 U | 0.0011 U | 0.0011 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B14 | 1.0 | 0.018 | **0.0095** | 0.0011 U | 0.0011 U | 0.0011 U |
| | 3.0 | 0.0095 | **0.0069** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.016 | **0.0092** | 0.00096 U | 0.00096 U | 0.00096 U |
| | 8.0 | 0.0076 | 0.0040 | 0.0014 U | 0.0014 U | 0.0014 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B12 | 1.0 | 0.028 | 0.0028 | 0.0012 U | 0.0012 U | 0.0012 U |
| | 2.8 | 0.0059 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.0089 | 0.0011 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 8.0 | 0.0014 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B9 | 1.0 | 0.021 | **0.020** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 2.0 | 0.0098 | 0.0059 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.0036 | 0.0028 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 8.0 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B8 | 1.0 | **0.33** | **0.36** | 0.0081 | 0.0015 | 0.00094 U |
| | 3.0 | 0.035 | **0.076** | 0.0053 | 0.0011 U | 0.0011 U |
| | 5.0 | **0.050** | **0.12** | 0.0088 | 0.00098 U | 0.00098 U |
| | 8.0 | 0.025 | **0.022** | 0.0015 U | 0.0015 U | 0.0015 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B7 | 1.0 | **0.26** | **0.48** | 0.0055 | 0.0013 | 0.00094 U |
| | 3.0 | 0.0073 | **0.019** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.026 | **0.057** | 0.0013 | 0.0010 U | 0.0010 U |
| | 6.9 | 0.0010 U | 0.0017 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 8.0 | 0.0059 | **0.0094** | 0.0012 U | 0.0012 U | 0.0012 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B6 | 1.0 | **0.64** | **0.32** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 3.0 | 0.040 | **0.036** | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.7 | **0.066** | **0.044** | 0.00096 U | 0.00096 U | 0.00096 U |
| | 8.0 | 0.015 | 0.0055 | 0.0014 U | 0.0014 U | 0.0014 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B10 | 1.0 | 0.019 | 0.00094 U | 0.00094 U | 0.00094 U | 0.00094 U |
| | 3.0 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 5.0 | 0.0015 | 0.00099 U | 0.00099 U | 0.00099 U | 0.00099 U |
| | 8.0 | 0.0031 | 0.0015 U | 0.0015 U | 0.0015 U | 0.0015 U |

| | DEPTH | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| P4-B11 | 1.0 | **0.054** | 0.0031 | 0.0010 U | 0.0010 U | 0.0010 U |
| | 3.0 | 0.005 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |
| | 5.0 | 0.0059 | 0.0011 U | 0.0011 U | 0.0011 U | 0.0011 U |
| | 8.0 | 0.0039 | 0.0010 U | 0.0010 U | 0.0010 U | 0.0010 U |

## LEGEND

● DIRECT-PUSH SOIL BORINGS

➤ STORMWATER MAINLINE (WITH INSTALL DATE AND FLOW DIRECTIONS)

➤ SANITARY SEWER MAIN LINE AND FLOW DIRECTION

➤ WATER MAIN LINE

▣ STORMWATER CATCH BASIN

● HYDRANT

⬢ SANITARY SEWER MANHOLE

SOIL RESULTS ARE IN MILLIGRAMS PER KILOGRAM

**BOLD** = INDICATES CONCENTRATIONS EXCEED WEST OF FOURTH GROUP SOIL INVESTIGATION PRELIMINARY CLEANUP LEVELS
U = INDICATES CONCENTRATIONS NOT DETECTED ABOVE THE STATED LABORATORY PRACTICAL QUANTITATION LIMIT
PCE = TETRACHLOROETHENE
TCE = TRICHLOROETHENE
cis-1,2-DCE = CIS-1,2-DICHLOROETHENE
trans-1,2-DCE = TRANS-1,2-DICHLOROETHENE
VC = VINYL CHLORIDE

N

0 30
SCALE IN FEET

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# FIGURE 3C

## PLANT 4 SOIL ANALYTICAL RESULTS AND CIS-1,2,DICHLOROETHENE SOIL GAS RESULTS
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5801 3RD AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: tperrin
Checked By: JK
Date: 5/7/2018
Disc Reference:
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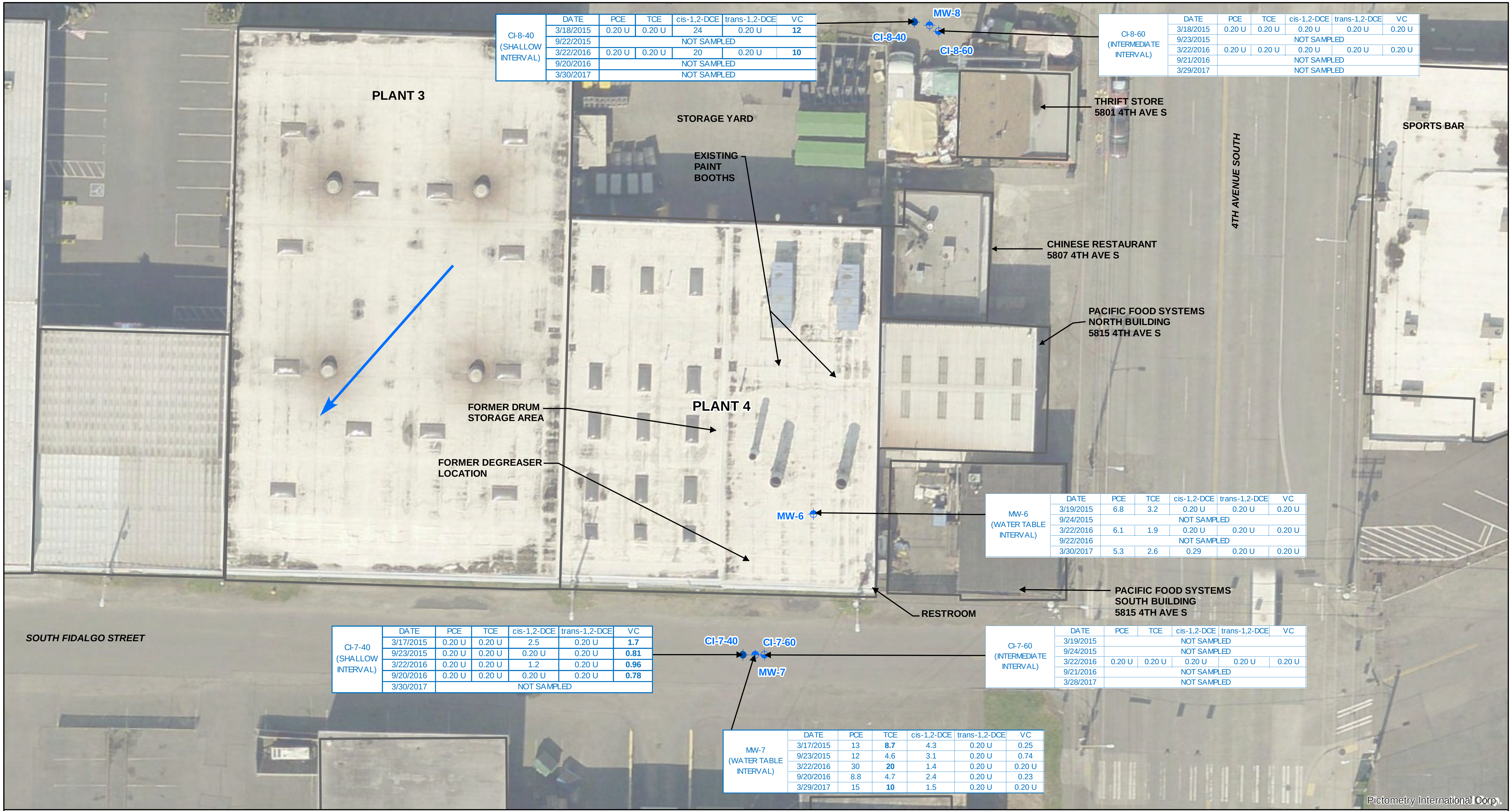

| CI-8-40 (SHALLOW INTERVAL) | DATE | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| | 3/18/2015 | 0.20 U | 0.20 U | 24 | 0.20 U | **12** |
| | 9/22/2015 | NOT SAMPLED | | | | |
| | 3/22/2016 | 0.20 U | 0.20 U | 20 | 0.20 U | **10** |
| | 9/20/2016 | NOT SAMPLED | | | | |
| | 3/30/2017 | NOT SAMPLED | | | | |

| CI-8-60 (INTERMEDIATE INTERVAL) | DATE | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| | 3/18/2015 | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| | 9/23/2015 | NOT SAMPLED | | | | |
| | 3/22/2016 | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| | 9/21/2016 | NOT SAMPLED | | | | |
| | 3/29/2017 | NOT SAMPLED | | | | |

| MW-6 (WATER TABLE INTERVAL) | DATE | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| | 3/19/2015 | 6.8 | 3.2 | 0.20 U | 0.20 U | 0.20 U |
| | 9/24/2015 | NOT SAMPLED | | | | |
| | 3/22/2016 | 6.1 | 1.9 | 0.20 U | 0.20 U | 0.20 U |
| | 9/22/2016 | NOT SAMPLED | | | | |
| | 3/30/2017 | 5.3 | 2.6 | 0.29 | 0.20 U | 0.20 U |

| CI-7-40 (SHALLOW INTERVAL) | DATE | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| | 3/17/2015 | 0.20 U | 0.20 U | 2.5 | 0.20 U | **1.7** |
| | 9/23/2015 | 0.20 U | 0.20 U | 0.20 U | 0.20 U | **0.81** |
| | 3/22/2016 | 0.20 U | 0.20 U | 1.2 | 0.20 U | **0.96** |
| | 9/20/2016 | 0.20 U | 0.20 U | 0.20 U | 0.20 U | **0.78** |
| | 3/30/2017 | NOT SAMPLED | | | | |

| CI-7-60 (INTERMEDIATE INTERVAL) | DATE | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| | 3/19/2015 | NOT SAMPLED | | | | |
| | 9/24/2015 | NOT SAMPLED | | | | |
| | 3/22/2016 | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| | 9/21/2016 | NOT SAMPLED | | | | |
| | 3/28/2017 | NOT SAMPLED | | | | |

| MW-7 (WATER TABLE INTERVAL) | DATE | PCE | TCE | cis-1,2-DCE | trans-1,2-DCE | VC |
|---|---|---|---|---|---|---|
| | 3/17/2015 | 13 | **8.7** | 4.3 | 0.20 U | 0.25 |
| | 9/23/2015 | 12 | 4.6 | 3.1 | 0.20 U | 0.74 |
| | 3/22/2016 | 30 | **20** | 1.4 | 0.20 U | 0.20 U |
| | 9/20/2016 | 8.8 | 4.7 | 2.4 | 0.20 U | 0.23 |
| | 3/29/2017 | 15 | **10** | 1.5 | 0.20 U | 0.20 U |

## LEGEND

| | |
|---|---|
| ⌖ | WATER TABLE INTERVAL MONITORING WELL |
| ● | SHALLOW INTERVAL MONITORING WELL |
| ⌖ | INTERMEDIATE INTERVAL MONITORING WELL |
| → | APPROXIMATE DIRECTION OF GROUNDWATER FLOW |

GROUNDWATER RESULTS ARE IN MICROGRAMS PER LITER

**BOLD** = INDICATES CONCENTRATIONS EXCEED APPLICABLE PRELIMINARY CLEANUP LEVEL FOR SPECIFIED WATER-BEARING ZONE.
U = INDICATES CONCENTRATIONS NOT DETECTED ABOVE THE STATED LABORATORY PRACTICAL QUANTITATION LIMIT
CVOC = CHLORINATED VOLATILE ORGANIC COMPOUND
PCE = TETRACHLOROETHENE
TCE = TRICHLOROETHENE
cis-1,2-DCE = CIS-1,2-DICHLOROETHENE
trans-1,2-DCE = TRANS-1,2-DICHLOROETHENE
VC = VINYL CHLORIDE

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# FIGURE 4

## PLANT 4 GROUNDWATER CVOC RESULTS
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5801 3RD AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: tperrin
Checked By: JK
Date: 5/7/2018
Disc Reference:
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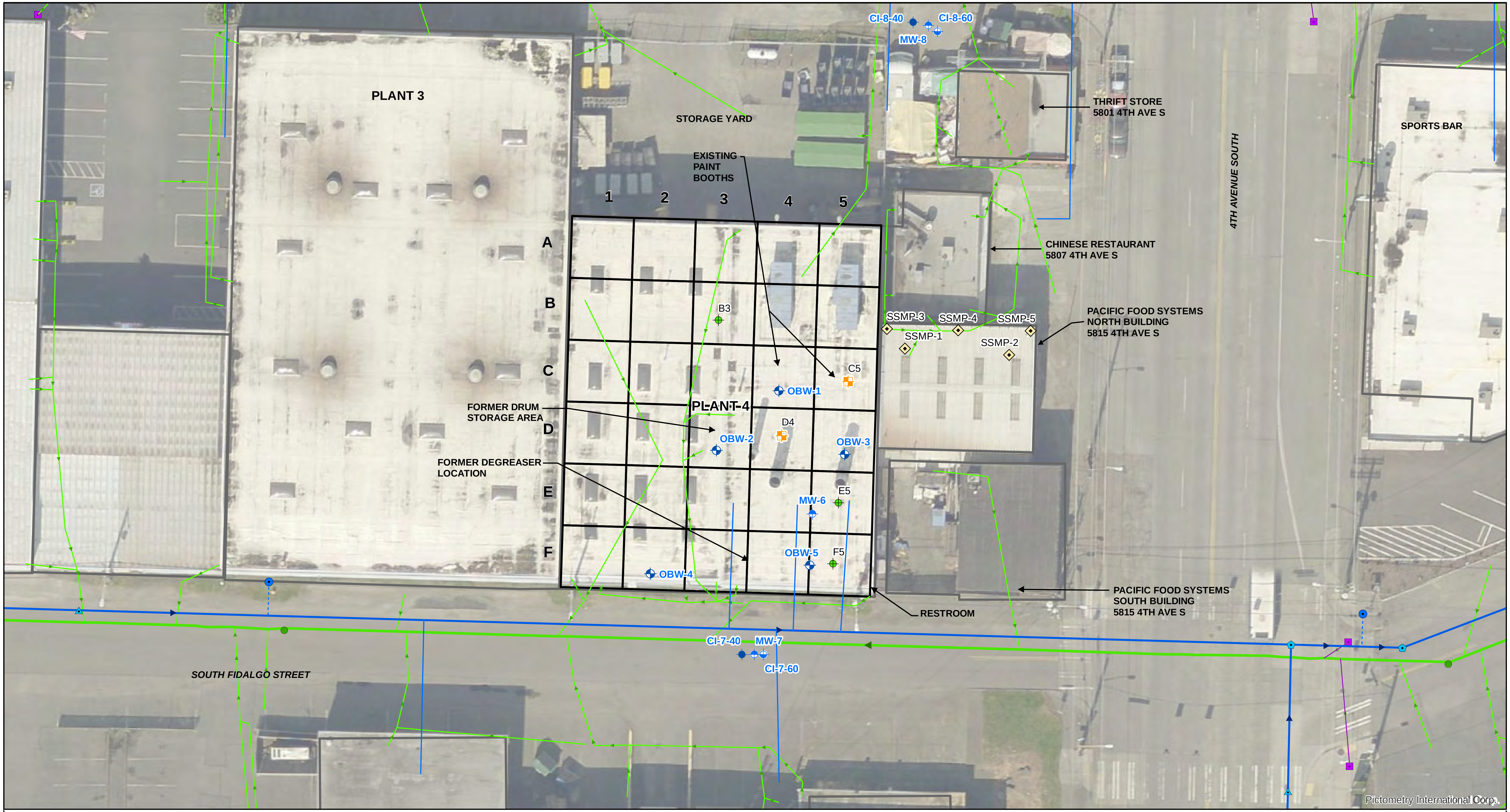

LEGEND

| | |
|---|---|
| ⊕ | PROPOSED OBSERVATION WELLS |
| ⊕ | WATER TABLE INTERVAL MONITORING WELL |
| ⊕ | SHALLOW INTERVAL MONITORING WELL |
| ⊕ | INTERMEDIATE INTERVAL MONITORING WELL |
| ⊕ | STAGE 1 LOW-PRESSURE ISCO INJECTION POINTS |
| ⊞ | STAGE 1 HIGH-PRESSURE ISCO INJECTION POINTS |
| ◈ | EXISTING SUBSLAB MONITORING PORT |
| ● | COMBINED SANITARY SEWER/STORMWATER MANHOLE |
| ➔ | COMBINED SANITARY SEWER/STORMWATER MAIN LINE AND FLOW DIRECTION |
| → | SANITARY SEWER LATERAL AND FLOW DIRECTION |
| ■ | STORMWATER CATCH BASIN |
| — | STORMWATER SIDE SEWER/LATERAL |
| ☐ | INJECTION GRID CELL |
| ● | HYDRANT |
| ▲ | WATER VALVE |
| ⬟ | WATER FITTING |
| ➔ | WATER DISTRIBUTION MAIN |
| — | WATER SERVICE LINE |
| - - - | HYDRANT LATERAL |

ISCO = IN SITU CHEMICAL OXIDATION

NOTES: FEATURES DISPLAYED IN THE MAP EXTENT UTILIZE COLORS THAT MAY NOT BE VISIBLE IF PRINTED IN BLACK AND WHITE.

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0 30
Scale in Feet

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FIGURE 5
PLANT 4 STAGE 1 ISCO INJECTION POINTS AND MONITORING WELLS
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5801 3RD AVENUE SOUTH
SEATTLE, WASHINGTON
FARALLON PN: 457-008

Drawn By: tperrin
Checked By: JM
Date: 5/8/2018
Disc Reference:
Path: Q:\Projects\457 CapitalIndust\008 PilotStudy\InterimWorkPlan\Revision_20180507\Figure5_ISCO_InjectionPoints_PMW.mxd

# TABLES

## REVISED CAPITAL INDUSTRIES PLANT 4 STAGE 1 FIELD IMPLEMENTATION WORK PLAN

West of 4th Group Site
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

# Table 1
# Summary of Preliminary Cleanup Levels
## Updated January 17, 2017
## West of 4th Group Site
## Capital Industries, Inc.
## 5801 3rd Avenue South
## Seattle, Washington
## Farallon PN: 457-008

| Constituent of Concern | Carcinogen or Non-Carcinogen | Preliminary Cleanup Levels | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil | | | | | Groundwater | | | | Air | | Surface Water | | Sediment |
| | | Puget Sound Background Concentrations for Metals[1] | Soil Cleanup Level Protective of Direct Contact Pathway (Unrestricted Land Use)[2] | Soil Cleanup Level Protective of Direct Contact Pathway (Industrial Land Use)[2] | Soil Cleanup Level Protective of Air Quality Based on Protection of Groundwater as Potable Drinking Water[3] | Soil Cleanup Level Protective of Groundwater Concentrations Protective of Surface Water Quality[4] | Groundwater Cleanup Level Protective of Air Quality Water Table Zone (Unrestricted Land Use)[5] | Groundwater Cleanup Level Protective of Air Quality Water Table Zone (Industrial Land Use)[5] | Groundwater Cleanup Level Protective of Surface Water[6] | Groundwater Cleanup Level Protective of Sediment[7] | Air Cleanup Level Protective of Inhalation Pathway (Unrestricted Land Use)[2] | Air Cleanup Level Protective of Inhalation Pathway (Industrial Land Use)[2] | Surface Water Cleanup Level Protective of Human Health[8] | Surface Water Cleanup Level Protective of Aquatic Life | Sediment Cleanup Level[9] |
| | | (milligrams/kilogram) | | | | | (micrograms/liter) | | | | (micrograms/cubic meter) | | (micrograms/liter) | | (milligrams/kilogram) |
| Tetrachloroethene | Carcinogen | -- | 476 | 21,000 | 0.08 | 0.044 | 116 | 482 | 2.9 | 36,000 | 9.6 | 40 | 2.9 | -- | 190 |
| Trichloroethene | Carcinogen | -- | 12 | 1,750 | 0.03 | 0.006 | 6.9 | 37 | 0.7 | 4,760,000 | 0.37 | 2 | 0.7 | 194 [12] | 8,950 |
| cis-1,2-dichloroethene | Non-Carcinogen | -- | 160 | 7,000 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| trans-1,2-dichloroethene | Non-Carcinogen | -- | 1,600 | 70,000 | 0.59 | 6 | 559 | 1,224 | 1,000 | -- | 27.4 | 60 | 1,000 | -- | -- |
| 1,1-dichloroethene | Non-Carcinogen | -- | 4,000 | 175,000 | 0.055 | 0.025 | 538 | 1,176 | 3.2 | -- | 91.4 | 200 | 3.2 | -- | -- |
| Vinyl chloride | Carcinogen | -- | 0.67 | 87.5 | 0.002 | 0.001 | 1.3 | 12.7 | 0.18 | 543,000 | 0.28 | 2.8 | 0.18 | 210 [13] | 202 |
| 1,4-dioxane | Carcinogen | -- | 10 | 1,310 | 0.004 | 0.32 | 2,551 | 25,510 | 78 | -- | 0.5 | 5 | 78 | -- | -- |
| Arsenic | Carcinogen | 20 | 20 | 87.5 | Not Applicable | 0.082 | Not Applicable | Not Applicable | 0.14 / 5 [10] | 241 | Not Applicable | Not Applicable | 0.14 / 5 [10] | 36 [14] | 7 |
| Barium | Non-Carcinogen | -- | 16,000 | 700,000 | Not Applicable | 824 | Not Applicable | Not Applicable | -- | -- | Not Applicable | Not Applicable | -- | -- | -- |
| Cadmium | Non-Carcinogen | 1 | 80 | 3,500 | Not Applicable | 1.2 | Not Applicable | Not Applicable | 8.8 | 760 | Not Applicable | Not Applicable | -- | 8.8 [15] | 5.1 |
| Copper | Non-Carcinogen | 36 | 3,200 | 140,000 | Not Applicable | 1.1 | Not Applicable | Not Applicable | 3.1 [11] | 18,000 | Not Applicable | Not Applicable | -- | 3.1 [15] | 390 |
| Iron | Non-Carcinogen | 58,700 | 58,700 | 2,450,000 | Not Applicable | -- | Not Applicable | Not Applicable | -- | -- | Not Applicable | Not Applicable | 1,000 | -- | -- |
| Manganese | Non-Carcinogen | 1,200 | 11,200 | 490,000 | Not Applicable | -- | Not Applicable | Not Applicable | 100 | -- | Not Applicable | Not Applicable | 100 | -- | -- |
| Nickel | Non-Carcinogen | 48 | 1,600 | 70,000 | Not Applicable | 11 | Not Applicable | Not Applicable | 8.2 | 2,200 | Not Applicable | Not Applicable | 100 | 8.2 [15] | 15.9 |
| Zinc | Non-Carcinogen | 85 | 24,000 | 1,050,000 | Not Applicable | 101 | Not Applicable | Not Applicable | 81 | 6,600 | Not Applicable | Not Applicable | 1,000 | 81 [15] | 410 |

NOTES:

Preliminary cleanup levels presented represent the most-stringent cleanup levels for the constituent of concern listed in the media indicated.

-- denotes no value is available. In the case of applicable or relevant and appropriate requirements (ARARs), the reference sources do not publish values for the noted chemicals. In the case of calculated values, one or more input parameters are not available.

Not Applicable denotes the constituent of concern will not affect the medium of potential concern due to an incomplete pathway.

Kd = distribution coefficient

Koc = soil organic carbon-water partition coefficient

PCE = tetrachloroethene

t-1,2-DCE = trans-1,2-dichloroethene

TCE = trichloroethene

[1] Background metals values from *Natural Background Soil Metals Concentrations in Washington State* dated October 1994, Washington State Department of Ecology (Ecology) Publication No. 94-115. Arsenic background from Washington State Model Toxics Control Act Cleanup Regulation (MTCA) Table 740-1, *Method A Soil Cleanup Levels for Unrestricted Land Uses.*

[2] Cleanup level is based on standard MTCA Method B (unrestricted land use) or Method C (industrial land use) values from the Cleanup and Risk Calculations tables (CLARC).

[3] Soil cleanup levels for protection of air quality are calculated using MTCA Equation 747-1, where the potable Method B groundwater cleanup level was used as Cw. Concentrations of hazardous substances in soil that meet the potable groundwater protection standard currently are considered sufficiently protective of the air pathway for unrestricted and industrial land uses.

[4] Soil cleanup levels for protection of surface water quality are calculated using MTCA Equation 747-1, where the groundwater cleanup level protective of surface water in this table was used as Cw.

[5] Groundwater cleanup levels protective of the air pathway for unrestricted land use (residential and commercial sites) and industrial land use were derived using the following equation: Gwcul = Aircul/GIVF.

[6] Human health and marine aquatic ecologic receptors were considered. See Surface Water Cleanup Levels Protective of Human Health and Aquatic Life (Columns N and O) in this table. The more-stringent value of the two receptors has been listed for the Groundwater Cleanup Level Protective of Surface Water.

[7] Groundwater screening levels based on the transfer of contaminants from groundwater to sediment were calculated by dividing the sediment screening level by the associated partition coefficients. Koc and Kd values are from MTCA. Fraction of carbon assumed at 0.02 based on Lower Duwamish Waterway Feasibility Study (AECOM 2012).

[8] The most-stringent exposure pathway for human health receptors is for consumption of fish. Listed values are based on ARARs contained in CLARC, with the following exceptions: (1) 1,4-dioxane is derived from MTCA Method B default values; (2) PCE, TCE, trans-DCE, vinyl chloride, nickel, and zinc are based on the U.S. Environmental Protection Agency (EPA) revised *CWA* [Clean Water Act]-*Human Health Criteria Applicable to Washington* dated November 15, 2016, "Organisms Only."

[9] Sediment has not been confirmed to be affected by groundwater discharge to surface water. Sediment cleanup levels were derived from the Lower Duwamish Waterway Superfund Site Record of Decisions (EPA 2014), which does not contain values for nickel, TCE, PCE, or vinyl chloride. These constituents also are not listed in the Sediment Management Standards (Chapter 173-204 of the Washington Administrative Code [WAC 173-204]). *EPA Region III BTAG* [Biological Technical Assistance Group] *Marine Sediment Screening Benchmarks* dated July 2006 have been listed for nickel, TCE, and PCE. EPA Region III has no value listed for vinyl chloride; therefore, the older Region 5 benchmarks were used (EPA 2003).

[10] Arsenic cleanup level of 5 micrograms per liter (µg/l) based on background concentrations for the state of Washington (MTCA Table 720-1).

[11] The surface water cleanup level for copper previously had been tabulated as 2.4 µg/l; however, this value is based on an approach using a site-specific water-effects ratio that has not been determined. This value was replaced with 3.1 µg/l, the National Recommended Water Quality Criteria - Aquatic Life Criteria Table published by EPA under Section 304 of the Federal Clean Water Act.

[12] Based on the Oak Ridge National Laboratory Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota.

[13] DeRooij, C. et al. 2004. *Euro Chlor Risk Assessment for the Marine Environment Osparcom Region: North Sea – Environmental Monitoring and Assessment.*

[14] WAC 173-201A-240.

[15] National Recommended Water Quality Criteria - Aquatic Life Criteria Table published by EPA under Section 304 of the Federal Clean Water Act.

Table updated on August 14, 2015 based on revisions to EPA Aquatic Water Quality Criteria; on July 20, 2016 based on Ecology comments on the Draft FS Reports for SU1 and SU2 (i.e., footnotes clarified, sediment values and surface water CULs protective of aquatic life added); and January 17, 2017 based on EPA revisions to the Clean Water Act Human Health criteria dated November 15, 2016.

# Table 2
# Summary of Soil Analytical Results for CI Plant 4
## West of 4th Group Site
## Capital Industries, Inc.
## 5801 3rd Avenue South
## Seattle, Washington
## Farallon PN: 457-008

| **Sample Identification** | **Sample Location** | **Sampled By** | **Sample Date** | **Sample Depth (feet)[1]** | **Analytical Results (milligrams per kilogram)[2]** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **PCE** | **TCE** | **cis-1,2-Dichloroethene** | **trans-1,2-Dichloroethene** | **Vinyl Chloride** |
| P4-B1-1.0 | P4-1 | Farallon | 10/17/2015 | 1.0 | 0.0085 | **0.045** | < 0.00098 | < 0.00098 | < 0.00098 |
| P4-B1-3.0 | P4-1 | Farallon | 10/17/2015 | 3.0 | 0.0013 | **0.0068** | < 0.00099 | < 0.00099 | < 0.00099 |
| P4-B1-5.0 | P4-1 | Farallon | 10/17/2015 | 5.0 | 0.0031 | **0.015** | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B1-7.8 | P4-1 | Farallon | 10/17/2015 | 7.8 | 0.0036 | **0.0068** | < 0.0016 | < 0.0016 | < 0.0016 |
| P4-B2-1.0 | P4-2 | Farallon | 10/17/2015 | 1.0 | < 0.00099 | 0.0039 | < 0.00099 | < 0.00099 | < 0.00099 |
| P4-B2-3.0 | P4-2 | Farallon | 10/17/2015 | 3.0 | < 0.0011 | < 0.0011 | < 0.0011 | < 0.0011 | < 0.0011 |
| P4-B2-5.0 | P4-2 | Farallon | 10/17/2015 | 5.0 | < 0.00096 | 0.0020 | < 0.00096 | < 0.00096 | < 0.00096 |
| P4-B2-8.0 | P4-2 | Farallon | 10/17/2015 | 8.0 | < 0.0015 | < 0.0015 | < 0.0015 | < 0.0015 | < 0.0015 |
| P4-B3-1.0 | P4-3 | Farallon | 10/17/2015 | 1.0 | < 0.00089 | **0.0069** | < 0.00089 | < 0.00089 | < 0.00089 |
| P4-B3-3.0 | P4-3 | Farallon | 10/17/2015 | 3.0 | < 0.0010 | 0.0028 | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B3-5.0 | P4-3 | Farallon | 10/17/2015 | 5.0 | < 0.0011 | 0.0028 | < 0.0011 | < 0.0011 | < 0.0011 |
| P4-B3-6.3 | P4-3 | Farallon | 10/17/2015 | 6.3 | < 0.0012 | 0.0053 | < 0.0012 | < 0.0012 | < 0.0012 |
| P4-B3-8.0 | P4-3 | Farallon | 10/17/2015 | 8.0 | < 0.0010 | < 0.0010 | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B4-1.0 | P4-4 | Farallon | 10/17/2015 | 1.0 | < 0.0010 | **0.060** | 0.0022 | < 0.0010 | < 0.0010 |
| P4-B4-3.0 | P4-4 | Farallon | 10/17/2015 | 3.0 | < 0.0011 | **0.0090** | < 0.0011 | < 0.0011 | < 0.0011 |
| P4-B4-5.0 | P4-4 | Farallon | 10/17/2015 | 5.0 | < 0.0010 | **0.010** | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B4-8.0 | P4-4 | Farallon | 10/17/2015 | 8.0 | < 0.0010 | < 0.0010 | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B5-1.0 | P4-5 | Farallon | 10/17/2015 | 1.0 | 0.012 | **0.013** | < 0.00099 | < 0.00099 | < 0.00099 |
| P4-B5-3.0 | P4-5 | Farallon | 10/17/2015 | 3.0 | 0.0087 | **0.010** | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B5-5.0 | P4-5 | Farallon | 10/17/2015 | 5.0 | 0.016 | **0.016** | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B5-6.0 | P4-5 | Farallon | 10/17/2015 | 6.0 | 0.023 | **0.023** | < 0.0012 | < 0.0012 | < 0.0012 |
| P4-B5-8.0 | P4-5 | Farallon | 10/17/2015 | 8.0 | 0.0094 | **0.0074** | < 0.0011 | < 0.0011 | < 0.0011 |
| **Preliminary Cleanup Levels for Soil** | | | | | **0.08[3]/0.044[4]** | **0.03[3]/0.006[4]** | **160[5]** | **0.59[3]/6[4]** | **0.002[3]/0.001[4]** |

# Table 2
# Summary of Soil Analytical Results for CI Plant 4
# West of 4th Group Site
# Capital Industries, Inc.
# 5801 3rd Avenue South
# Seattle, Washington
# Farallon PN: 457-008

| Sample Identification | Sample Location | Sampled By | Sample Date | Sample Depth (feet)[1] | Analytical Results (milligrams per kilogram)[2] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **PCE** | **TCE** | **cis-1,2-Dichloroethene** | **trans-1,2-Dichloroethene** | **Vinyl Chloride** |
| P4-B6-1.0 | P4-6 | Farallon | 10/17/2015 | 1.0 | **0.64** | **0.32** | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B6-3.0 | P4-6 | Farallon | 10/17/2015 | 3.0 | 0.040 | **0.036** | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B6-5.7 | P4-6 | Farallon | 10/17/2015 | 5.7 | **0.066** | **0.044** | < 0.00096 | < 0.00096 | < 0.00096 |
| P4-B6-8.0 | P4-6 | Farallon | 10/17/2015 | 8.0 | 0.015 | 0.0055 | < 0.0014 | < 0.0014 | < 0.0014 |
| P4-B7-1.0 | P4-7 | Farallon | 10/17/2015 | 1.0 | **0.26** | **0.48** | 0.0055 | 0.0013 | < 0.00094 |
| P4-B7-3.0 | P4-7 | Farallon | 10/17/2015 | 3.0 | 0.0073 | **0.019** | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B7-5.0 | P4-7 | Farallon | 10/17/2015 | 5.0 | 0.026 | **0.057** | 0.0013 | < 0.0010 | < 0.0010 |
| P4-B7-6.9 | P4-7 | Farallon | 10/17/2015 | 6.9 | < 0.0010 | 0.0017 | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B7-8.0 | P4-7 | Farallon | 10/17/2015 | 8.0 | 0.0059 | **0.0094** | < 0.0012 | < 0.0012 | < 0.0012 |
| P4-B8-1.0 | P4-8 | Farallon | 10/17/2015 | 1.0 | **0.33** | **0.36** | 0.0081 | 0.0015 | < 0.00094 |
| P4-B8-3.0 | P4-8 | Farallon | 10/17/2015 | 3.0 | 0.035 | **0.076** | 0.0053 | < 0.0011 | < 0.0011 |
| P4-B8-5.0 | P4-8 | Farallon | 10/17/2015 | 5.0 | **0.050** | **0.12** | 0.0088 | < 0.00098 | < 0.00098 |
| P4-B8-8.0 | P4-8 | Farallon | 10/17/2015 | 8.0 | 0.025 | **0.022** | < 0.0015 | < 0.0015 | < 0.0015 |
| P4-B9-1.0 | P4-9 | Farallon | 10/17/2015 | 1.0 | 0.021 | **0.020** | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B9-2.0 | P4-9 | Farallon | 10/17/2015 | 2.0 | 0.0098 | 0.0059 | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B9-5.0 | P4-9 | Farallon | 10/17/2015 | 5.0 | 0.0036 | 0.0028 | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B9-8.0 | P4-9 | Farallon | 10/17/2015 | 8.0 | < 0.0010 | < 0.0010 | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B10-1.0 | P4-10 | Farallon | 10/17/2015 | 1.0 | 0.019 | < 0.00094 | < 0.00094 | < 0.00094 | < 0.00094 |
| P4-B10-3.0 | P4-10 | Farallon | 10/17/2015 | 3.0 | < 0.0011 | < 0.0011 | < 0.0011 | < 0.0011 | < 0.0011 |
| P4-B10-5.0 | P4-10 | Farallon | 10/17/2015 | 5.0 | 0.0015 | < 0.00099 | < 0.00099 | < 0.00099 | < 0.00099 |
| P4-B10-8.0 | P4-10 | Farallon | 10/17/2015 | 8.0 | 0.0031 | < 0.0015 | < 0.0015 | < 0.0015 | < 0.0015 |
| **Preliminary Cleanup Levels for Soil** | | | | | **0.08[3]/0.044[4]** | **0.03[3]/0.006[4]** | **160[5]** | **0.59[3]/6[4]** | **0.002[3]/0.001[4]** |

# Table 2
## Summary of Soil Analytical Results for CI Plant 4
## West of 4th Group Site
## Capital Industries, Inc.
## 5801 3rd Avenue South
## Seattle, Washington
## Farallon PN: 457-008

| Sample Identification | Sample Location | Sampled By | Sample Date | Sample Depth (feet)[1] | Analytical Results (milligrams per kilogram)[2] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **PCE** | **TCE** | **cis-1,2-Dichloroethene** | **trans-1,2-Dichloroethene** | **Vinyl Chloride** |
| P4-B11-1.0 | P4-11 | Farallon | 10/17/2015 | 1.0 | **0.054** | 0.0031 | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B11-3.0 | P4-11 | Farallon | 10/17/2015 | 3.0 | 0.0050 | < 0.0010 | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B11-5.0 | P4-11 | Farallon | 10/17/2015 | 5.0 | 0.0059 | < 0.0011 | < 0.0011 | < 0.0011 | < 0.0011 |
| P4-B11-8.0 | P4-11 | Farallon | 10/17/2015 | 8.0 | 0.0039 | < 0.0010 | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B12-1.0 | P4-12 | Farallon | 10/17/2015 | 1.0 | 0.028 | 0.0028 | < 0.0012 | < 0.0012 | < 0.0012 |
| P4-B12-2.8 | P4-12 | Farallon | 10/17/2015 | 2.8 | 0.0059 | < 0.0011 | < 0.0011 | < 0.0011 | < 0.0011 |
| P4-B12-5.0 | P4-12 | Farallon | 10/17/2015 | 5.0 | 0.0089 | 0.0011 | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B12-8.0 | P4-12 | Farallon | 10/17/2015 | 8.0 | 0.0014 | < 0.0011 | < 0.0011 | < 0.0011 | < 0.0011 |
| P4-B13-1.0 | P4-13 | Farallon | 10/17/2015 | 1.0 | 0.0029 | 0.0040 | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B13-3.0 | P4-13 | Farallon | 10/17/2015 | 3.0 | < 0.0011 | < 0.0011 | < 0.0011 | < 0.0011 | < 0.0011 |
| P4-B13-5.0 | P4-13 | Farallon | 10/17/2015 | 5.0 | < 0.00097 | < 0.00097 | < 0.00097 | < 0.00097 | < 0.00097 |
| P4-B13-8.0 | P4-13 | Farallon | 10/17/2015 | 8.0 | 0.0016 | 0.0018 | < 0.0011 | < 0.0011 | < 0.0011 |
| P4-B14-1.0 | P4-14 | Farallon | 10/17/2015 | 1.0 | 0.018 | **0.0095** | < 0.0011 | < 0.0011 | < 0.0011 |
| P4-B14-3.0 | P4-14 | Farallon | 10/17/2015 | 3.0 | 0.0095 | **0.0069** | < 0.0010 | < 0.0010 | < 0.0010 |
| P4-B14-5.0 | P4-14 | Farallon | 10/17/2015 | 5.0 | 0.016 | **0.0092** | < 0.00096 | < 0.00096 | < 0.00096 |
| P4-B14-8.0 | P4-14 | Farallon | 10/17/2015 | 8.0 | 0.0076 | 0.0040 | < 0.0014 | < 0.0014 | < 0.0014 |
| **Preliminary Cleanup Levels for Soil** | | | | | **0.08[3]/0.044[4]** | **0.03[3]/0.006[4]** | **160[5]** | **0.59[3]/6[4]** | **0.002[3]/0.001[4]** |

# Table 2
# Summary of Soil Analytical Results for CI Plant 4
## West of 4th Group Site
## Capital Industries, Inc.
## 5801 3rd Avenue South
## Seattle, Washington
## Farallon PN: 457-008

| Sample Identification | Sample Location | Sampled By | Sample Date | Sample Depth (feet)[1] | Analytical Results (milligrams per kilogram)[2] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | PCE | TCE | cis-1,2-Dichloroethene | trans-1,2-Dichloroethene | Vinyl Chloride |

NOTES:

Results in **bold** denote reporting limits that exceed the most-conservative preliminary cleanup level.

< denotes analyte not detected at or exceeding the laboratory reporting limit listed.

[1] Depth in feet below ground surface.

[2] Analyzed by U.S. Environmental Protection Agency Method 8260B.

[3] Soil cleanup levels for protection of air quality. These are preliminary values only. Values were calculated using the Washington State Model Toxics Control Act Cleanup Regulation (MTCA) Equation 747-1, where the potable Method B groundwater cleanup level was used as $C_w$. Concentrations of hazardous substances in soil that meet the potable groundwater protection standard currently are considered sufficiently protective of the air pathway for unrestricted and industrial land uses.

[4] Soil cleanup levels for protection of surface water quality. These are preliminary values only. Values were calculated using MTCA Equation 747-1, where the groundwater cleanup level protective of surface water in this table was used as $C_w$.

[5] Cleanup level is based on standard MTCA Method B (unrestricted land use) values from the Cleanup and Risk Calculation tables. <https://fortress.wa.gov/ecy/clarc/Reporting/ChemicalQuery.aspx>

CI = Capital Industries, Inc.
Farallon = Farallon Consulting, L.L.C.
PCE = tetrachloroethene
TCE = trichloroethene

# Table 3
## Summary of Groundwater Analytical Results for CI Plant 4
West of 4th Group Site
Capital Industries, Inc.
5801 3rd Avenue South
Seattle, Washington
Farallon PN: 457-008

| Sample Identification | Sample Location | Date | Analytical Results (micrograms per liter)[1] | | | | |
|---|---|---|---|---|---|---|---|
| | | | PCE | TCE | cis-1,2-Dichloroethene | trans-1,2-Dichloroethene | Vinyl Chloride |
| **Water Table Interval** | | | | | | | |
| MW-6-032410 | MW-6 | 3/24/2010 | 11 | **7.0** | 1.3 | < 0.20 | < 0.20 |
| MW-6-061710 | MW-6 | 6/17/2010 | 5.5 | 6.8 | 3.9 | < 0.20 | < 0.20 |
| MW-6-092810 | MW-6 | 9/28/2010 | 10 | 5.3 | 0.28 | < 0.20 | < 0.20 |
| MW-6-121610 | MW-6 | 12/16/2010 | 11 | 6.8 | 2.7 | < 0.20 | < 0.20 |
| MW-6-031811 | MW-6 | 3/18/2011 | 6.2 | 3.4 | 0.83 | < 0.20 | < 0.20 |
| MW-6-031915 | MW-6 | 3/19/2015 | 6.8 | 3.2 | < 0.20 | < 0.20 | < 0.20 |
| MW-6-032216 | MW-6 | 3/22/2016 | 6.1 | 1.9 | < 0.20 | < 0.20 | < 0.20 |
| MW-6-033017 | MW-6 | 3/30/2017 | 5.3 | 2.6 | 0.29 | < 0.20 | < 0.20 |
| MW-7-032410 | MW-7 | 3/24/2010 | 22 | **17** | 5.9 | < 0.20 | < 0.20 |
| MW-7-061710 | MW-7 | 6/17/2010 | 9.4 J | **8.1** | 5.8 | < 0.20 | 0.43 |
| DUP-MW-7-061710 | MW-7 | 6/17/2010 | 13 J | **9.3** | 6.2 | < 0.20 | 0.38 |
| MW-7-093010 | MW-7 | 9/30/2010 | 17 | **9.7** | 3.8 | < 0.20 | 0.44 |
| DUP-MW-7-093010 | MW-7 | 9/30/2010 | 18 | **9.6** | 3.8 | < 0.20 | 0.45 |
| MW-7-121410 | MW-7 | 12/14/2010 | 2.4 J | 6.5 | 4.3 | < 0.20 | 0.57 |
| MW-7-121410-DUP | MW-7 | 12/14/2010 | 3.5 J | 5.8 | 4.3 | < 0.20 | 0.47 |
| MW-7-031511 | MW-7 | 3/15/2011 | 5.3 | **7.3** | 3.5 | < 0.20 | 0.28 |
| DUP-MW-7-031511 | MW-7 | 3/15/2011 | 5.8 | **7.9** | 3.3 | < 0.20 | 0.22 |
| MW-7-092911 | MW-7 | 9/29/2011 | 17 | **9.2** | 3.4 | < 0.20 | 0.39 |
| MW-7-050412 | MW-7 | 5/4/2012 | 26 | **19** | 2.9 | < 0.20 | < 0.20 |
| MW-7-092612 | MW-7 | 9/26/2012 | 3.6 | 4.7 | 3.2 | < 0.20 | < 0.20 |
| MW-7-031313 | MW-7 | 3/13/2013 | 21 | **14** | 2.9 | < 0.20 | < 0.20 |
| MW-7-080813 | MW-7 | 8/8/2013 | 8.6 | 4.6 | 4.7 | < 0.20 | < 0.20 |
| MW-7-031214 | MW-7 | 3/12/2014 | 21 | **12** | 2.8 | < 0.20 | < 0.20 |
| MW-7-092314 | MW-7 | 9/23/2014 | 11 | 5.5 | 3.3 | < 0.20 | 0.20 |
| MW-7-031715 | MW-7 | 3/17/2015 | 13 | **8.7** | 4.3 | < 0.20 | 0.25 |
| MW-7-092315 | MW-7 | 9/23/2015 | 12 | 4.6 | 3.1 | < 0.20 | 0.74 |
| **Preliminary Cleanup Levels-Water Table Interval** | | | **116 [2]** | **6.9 [2]** | **NR [3]** | **559 [2]** | **1.3 [2]** |

# Table 3
# Summary of Groundwater Analytical Results for CI Plant 4
## West of 4th Group Site
## Capital Industries, Inc.
## 5801 3rd Avenue South
## Seattle, Washington
## Farallon PN: 457-008

| Sample Identification | Sample Location | Date | Analytical Results (micrograms per liter)[1] | | | | |
|---|---|---|---|---|---|---|---|
| | | | PCE | TCE | cis-1,2-Dichloroethene | trans-1,2-Dichloroethene | Vinyl Chloride |
| **Water Table Interval** | | | | | | | |
| MW-7-032216 | MW-7 | 3/22/2016 | 30 | **20** | 1.4 | < 0.20 | < 0.20 |
| MW-7-092016 | MW-7 | 9/20/2016 | 8.8 | 4.7 | 2.4 | < 0.20 | 0.23 |
| CI-MW-7-032917 | MW-7 | 3/29/2017 | 15 | **10** | 1.5 | < 0.20 | < 0.20 |
| MW-8-092712 | MW-8 | 9/27/2012 | < 0.20 | < 0.20 | 0.67 | < 0.20 | < 0.20 |
| MW-8-032410 | MW-8 | 3/24/2010 | < 0.20 | < 0.20 | 0.26 | < 0.20 | < 0.20 |
| MW-8-061610 | MW-8 | 6/16/2010 | < 0.20 | < 0.20 | 0.3 | < 0.20 | < 0.20 |
| MW-8-093010 | MW-8 | 9/30/2010 | < 0.20 | < 0.20 | 0.63 | < 0.20 | < 0.20 |
| MW-8-121610 | MW-8 | 12/16/2010 | < 0.20 | 0.21 | 0.75 | < 0.20 | < 0.20 |
| MW-8-031511 | MW-8 | 3/15/2011 | < 0.20 | < 0.20 | 0.44 | < 0.20 | < 0.20 |
| MW-8-092911 | MW-8 | 9/29/2011 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | < 0.20 |
| MW-8-050412 | MW-8 | 5/4/2012 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | < 0.20 |
| **Preliminary Cleanup Levels-Water Table Interval** | | | **116** [2] | **6.9** [2] | **NR** [3] | **559** [2] | **1.3** [2] |
| **Shallow Interval** | | | | | | | |
| CI-7-40-032510 | CI-7-40 | 3/25/2010 | < 0.20 | < 0.20 | 1.0 | < 0.20 | **2.3** |
| CI-7-40-061710 | CI-7-40 | 6/17/2010 | < 0.20 | < 0.20 | 1.8 | < 0.20 | **3.6** |
| CI-7-40-093010 | CI-7-40 | 9/30/2010 | < 0.20 | < 0.20 | 1.5 | < 0.20 | **3.3** |
| CI-7-40-121410 | CI-7-40 | 12/14/2010 | < 0.20 | < 0.20 | 2.3 | < 0.20 | **2.6** |
| CI-7-40-031611 | CI-7-40 | 3/16/2011 | < 0.20 | < 0.20 | 2.5 | < 0.20 | **2.7** |
| CI-7-40-031313 | CI-7-40 | 3/13/2013 | < 0.20 | < 0.20 | 0.78 | < 0.20 | **1.1** |
| CI-7-40-080813 | CI-7-40 | 8/8/2013 | 0.31 | < 0.20 | < 0.20 | < 0.20 | **0.80** |
| CI-7-40-031214 | CI-7-40 | 3/12/2014 | < 0.20 | < 0.20 | 2.0 | < 0.20 | **1.5** |
| CI-7-40-092314 | CI-7-40 | 9/23/2014 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | **0.46** |
| CI-7-40-031715 | CI-7-40 | 3/17/2015 | < 0.20 | < 0.20 | 2.5 | < 0.20 | **1.7** |
| CI-7-40-092315 | CI-7-40 | 9/23/2015 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | **0.81** |
| CI-7-40-032216 | CI-7-40 | 3/22/2016 | < 0.20 | < 0.20 | 1.2 | < 0.20 | **0.96** |
| CI-7-40-092016 | CI-7-40 | 9/20/2016 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | **0.78** |
| **Preliminary Cleanup Levels-Shallow Interval** | | | **2.9** [4] | **0.7** [4] | **NR** [3] | **1,000** [4] | **0.18** [4] |

# Table 3
## Summary of Groundwater Analytical Results for CI Plant 4
## West of 4th Group Site
## Capital Industries, Inc.
## 5801 3rd Avenue South
## Seattle, Washington
## Farallon PN: 457-008

| | | | Analytical Results (micrograms per liter)[1] | | | | |
|---|---|---|---|---|---|---|---|
| **Sample Identification** | **Sample Location** | **Date** | **PCE** | **TCE** | **cis-1,2-Dichloroethene** | **trans-1,2-Dichloroethene** | **Vinyl Chloride** |
| CI-8-40-032410 | CI-8-40 | 3/24/2010 | < 0.20 | < 0.20 | 29 | < 0.20 | **17** |
| CI-8-40-061610 | CI-8-40 | 6/16/2010 | < 0.20 | < 0.20 | 15 | < 0.20 | **13** |
| CI-8-40-093010 | CI-8-40 | 9/30/2010 | < 0.20 | < 0.20 | 8.9 | < 0.20 | **12** |
| CI-8-40-121610 | CI-8-40 | 12/16/2010 | < 0.20 | < 0.20 | 25 | < 0.20 | **19** |
| CI-8-40-031511 | CI-8-40 | 3/15/2011 | < 0.20 | < 0.20 | 24 | < 0.20 | **14** |
| CI-8-40-092911 | CI-8-40 | 9/29/2011 | < 0.20 | < 0.20 | 9.2 | < 0.20 | **8.7** |
| CI-8-40-050412 | CI-8-40 | 5/4/2012 | < 0.20 | < 0.20 | 22 | < 0.20 | **13** |
| CI-8-40-092712 | CI-8-40 | 9/27/2012 | < 0.20 | < 0.20 | 8.2 | < 0.20 | **8.0** |
| CI-8-40-031413 | CI-8-40 | 3/14/2013 | < 0.20 | < 0.20 | 15 | < 0.20 | **10** |
| CI-8-40-031314 | CI-8-40 | 3/13/2014 | < 0.20 | < 0.20 | 25 | < 0.20 | **13** |
| CI-8-40-031815 | CI-8-40 | 3/18/2015 | < 0.20 | < 0.20 | 24 | < 0.20 | **12** |
| CI-8-40-032216 | CI-8-40 | 3/22/2016 | < 0.20 | < 0.20 | 20 | < 0.20 | **10** |
| **Preliminary Cleanup Levels-Shallow Interval** | | | **2.9**[4] | **0.7**[4] | **NR**[3] | **1,000**[4] | **0.18**[4] |
| **Intermediate Interval** | | | | | | | |
| CI-7-60-032410 | CI-7-60 | 3/24/2010 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | **0.46** |
| CI-7-60-061710 | CI-7-60 | 6/17/2010 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | **0.78** |
| CI-7-60-093010 | CI-7-60 | 9/30/2010 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | **0.53** |
| CI-7-60-121410 | CI-7-60 | 12/14/2010 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | **0.45** |
| CI-7-60-031511 | CI-7-60 | 3/15/2011 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | **0.40** |
| CI-7-60-031214 | CI-7-60 | 3/12/2014 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | < 0.20 |
| CI-7-60-031313 | CI-7-60 | 3/13/2013 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | < 0.20 |
| CI-7-60-032216 | CI-7-60 | 3/22/2016 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | < 0.20 |
| **Preliminary Cleanup Levels-Intermediate Interval** | | | **2.9**[4] | **0.7**[4] | **NR**[3] | **1,000**[4] | **0.18**[4] |

# Table 3
# Summary of Groundwater Analytical Results for CI Plant 4
West of 4th Group Site
Capital Industries, Inc.
5801 3rd Avenue South
Seattle, Washington
Farallon PN: 457-008

| Sample Identification | Sample Location | Date | Analytical Results (micrograms per liter)[1] PCE | TCE | cis-1,2-Dichloroethene | trans-1,2-Dichloroethene | Vinyl Chloride |
|---|---|---|---|---|---|---|---|
| CI-8-60-032410 | CI-8-60 | 3/24/2010 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | < 0.20 |
| CI-8-60-061610 | CI-8-60 | 6/16/2010 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | < 0.20 |
| CI-8-60-093010 | CI-8-60 | 9/30/2010 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | < 0.20 |
| CI-8-60-121610 | CI-8-60 | 12/16/2010 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | **0.37** |
| CI-8-60-031511 | CI-8-60 | 3/15/2011 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | **0.22** |
| CI-8-60-031815 | CI-8-60 | 3/18/2015 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | < 0.20 |
| CI-8-60-032216 | CI-8-60 | 3/22/2016 | < 0.20 | < 0.20 | < 0.20 | < 0.20 | < 0.20 |
| **Preliminary Cleanup Levels-Intermediate Interval** | | | **2.9** [4] | **0.7** [4] | **NR** [3] | **1,000** [4] | **0.18** [4] |

NOTES:

Results in **bold** denote concentrations exceeding applicable cleanup levels.

< denotes analyte not detected at or exceeding the laboratory reporting limit listed.

[1] Analyzed by U.S. Environmental Protection Agency Method 8260B or 8260C.

[2] Groundwater cleanup levels protective of the air pathway for unrestricted land use (residential and commercial sites) and industrial land use were derived using the following equation:
Gwcul = Aircul/GIVF.

[3] NR denotes "not researched," which indicates that no regulatory standards or toxicity information is available for the constituent of concern to derive a cleanup level for the medium of potential concern.

[4] Groundwater cleanup levels protective of the surface water pathway.

Intermediate Interval = groundwater collected from depths below 40 feet below ground surface

J = result is an estimate

PCE = tetrachloroethene

Shallow Interval = groundwater collected from 20 to 40 feet below ground surface

TCE = trichloroethene

Water Table Interval = groundwater collected from first-encountered groundwater to 20 feet below ground surface

# Table 4
# Summary of Natural Attenuation and Water Quality Parameters
# West of 4th Group Site
# Capital Industries, Inc.
# 5801 3rd Avenue South
# Seattle, Washington
# Farallon PN: 457-008

| Sample Location | Sample Date | Electron Receptors | | | Total and Dissolved Metals | | | | Metabolic By-products | | | Water Quality Parameters [1] | | | | Available Organic Carbon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dissolved Oxygen [1] (mg/l) | Nitrate[2] (mg/l) | Sulfate[3] (mg/l) | Total Iron[4] (µg/l) | Ferrous Iron[5] (mg/l) | Total Manganese[4] (µg/l) | Manganese (II)[5] (mg/l) | Methane[6] (µg/l) | Ethane[6] (µg/l) | Ethene[6] (µg/l) | pH | Temperature (°Celsius) | Conductivity (mS/cm) | ORP (mV) | TOC[7] (mg/l) |
| **Water Table Interval** | | | | | | | | | | | | | | | | |
| MW-6 | 3/24/2010 | 0.37 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.03 | 16.23 | 0.24 | 78 | NA |
| | 6/17/2010 | 1.19 | NA | NA | 2,900 | NA | 250 | NA | NA | NA | NA | 6.20 | 16.32 | 0.23 | 36.8 | NA |
| | 9/28/2010 | 2.08 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.65 | 14.64 | 0.224 | 53 | NA |
| | 12/16/2010 | 7.29 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.66 | 16.51 | 0.21 | 207.7 | NA |
| | 3/18/2011 | 0.29 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.24 | 15.45 | 0.243 | 82.8 | NA |
| | 3/19/2015 | 0.67 | NA | NA | NA | 0.2 | NA | < 0.1 | NA | NA | NA | 5.94 | 15.85 | 0.396 | 83.5 | NA |
| | 3/22/2016 | 0.38 | NA | NA | NA | 1.0 | NA | < 0.1 | NA | NA | NA | 5.98 | 16.05 | 0.295 | 85.2 | NA |
| | 3/30/2017 | 0.56 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.12 | 16.2 | 0.370 | 136.3 | NA |
| MW-7 | 3/24/2010 | 0.43 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 5.70 | 16.06 | 0.285 | 47.8 | NA |
| | 6/17/2010 | 1.05 | 3.2 J | 42 | 42,000 J | 5.41 | 280 | NA | 200 J | 53 J | < 15 | 7.04 | 14.81 | 0.243 | 88.2 | NA |
| | 9/30/2010 | 0.59 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.48 | 18.00 | 0.283 | -30 | NA |
| | 12/14/2010 | 0.57 | 0.43 J | 38 | 18,000 | NA | 220 | NA | 83 | 21 | < 6 | 6.52 | 14.49 | 0.239 | 104.5 | NA |
| | 3/15/2011 | 0.70 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.40 | 12.68 | 0.362 | 67.9 | NA |
| | 9/29/2011 | 0.90 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.43 | 17.31 | 0.236 | -23.2 | NA |
| | 5/4/2012 | 1.98 | NA | NA | 38,000 | NA | 100 | NA | NA | NA | NA | 6.14 | 13.84 | 0.210 | 28.2 | NA |
| | 3/13/2013 | 2.06 | 0.92 | 21 | 3,300 | 2 | 44 | < 0.1 | 2.8 | 1.2 | < 0.50 | 6.13 | 13.21 | 0.128 | 25.5 | 2 |
| | 8/8/2013 | 0.38 | 2.9 | 48 | 16,000 | 1.6 | 320 | < 0.1 | 7.5 | 1.4 | < 0.50 | 6.59 | 16.8 | 0.543 | 62.9 | 2.8 |
| | 3/12/2014 | 1.38 | 8.2 | 51 | 7,300 | 1.2 | 240 | < 0.1 | 21 | 3.8 | < 1.5 | 6.16 | 14.55 | 0.369 | 141.4 | 2.4 |
| | 9/23/2014 | 0.62 | 2.7 | 60 | 8,700 | 2.6 | 250 | < 0.1 | 20 | 3.2 | < 1.0 | 6.37 | 18.73 | 0.386 | -73 | 3.1 |
| | 3/17/2015 | IE | 1.1 | 46 | 8,700 | < 0.2 | 250 | < 0.1 | 59 | 8.7 | < 0.50 | 5.90 | 15.11 | 0.317 | 81.1 | 3.7 |
| | 9/23/2015 | 0.69 | 4.1 | 34 | NA | 3 | NA | < 0.1 | 220 | 30 | < 0.50 | 6.15 | 18.52 | 0.366 | -22 | 3.8 |
| | 3/22/2016 | 2.94 | 2.1 | 36 | 8,000 | 1.0 | 68 | < 0.1 | 9.2 | 0.99 | < 0.50 | 5.92 | 13.81 | 0.260 | 74.4 | 2.8 |
| | 9/20/2016 | 0.38 | 6.3 | 48 | 70,000 | 2.0 | 210 | < 0.1 | 60 | 8.0 | < 0.50 | 6.06 | 18.0 | 0.3833 | 17.8 | 7.3 |
| | 3/29/2017 | 2.36 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.06 | 14.0 | 0.318 | 67.1 | NA |

# Table 4
# Summary of Natural Attenuation and Water Quality Parameters
West of 4th Group Site
Capital Industries, Inc.
5801 3rd Avenue South
Seattle, Washington
Farallon PN: 457-008

| Sample Location | Sample Date | Electron Receptors | | | Total and Dissolved Metals | | | | Metabolic By-products | | | Water Quality Parameters [1] | | | | Available Organic Carbon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Dissolved Oxygen [1] (mg/l) | Nitrate[2] (mg/l) | Sulfate[3] (mg/l) | Total Iron[4] (µg/l) | Ferrous Iron[5] (mg/l) | Total Manganese[4] (µg/l) | Manganese (II)[5] (mg/l) | Methane[6] (µg/l) | Ethane[6] (µg/l) | Ethene[6] (µg/l) | pH | Temperature (°Celsius) | Conductivity (mS/cm) | ORP (mV) | TOC[7] (mg/l) |
| **Water Table Interval** | | | | | | | | | | | | | | | | |
| MW-8 | 3/24/2010 | 0.32 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 5.85 | 14.77 | 0.410 | 51 | NA |
| | 6/16/2010 | 0.66 | NA | NA | 58,000 | NA | 250 | NA | NA | NA | NA | 6.40 | 14.70 | 0.277 | 95.9 | NA |
| | 9/30/2010 | 0.74 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.14 | 17.31 | 0.354 | -2.4 | NA |
| | 12/16/2010 | 1.70 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.22 | 15.39 | 0.288 | 186.2 | NA |
| | 3/15/2011 | 2.83 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 7.54 | 13.03 | 0.421 | 75.9 | NA |
| | 9/29/2011 | 0.88 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.09 | 19.24 | 0.325 | 38.8 | NA |
| | 5/4/2012 | 2.59 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 13.74 | 0.260 | 88.9 | NA |
| | 3/14/2013 | 0.47 | 1 | 98 | 1,600 | 1 | 190 | < 0.1 | < 1.0 | < 0.50 | < 0.50 | 5.48 | 13.87 | 0.411 | 31.1 | 2.3 |
| | 3/13/2014 | 2.25 | 2.3 | 74 | 3,300 | 1 | 210 | < 0.1 | < 0.50 | < 0.50 | < 0.50 | 5.90 | 14.22 | 0.462 | 255.5 | 2.6 |
| | 9/23/2014 | 0.49 | 0.71 | 59 | 930 | 0.8 | 160 | < 0.1 | < 0.50 | < 0.50 | < 0.50 | 6.17 | 19.8 | 0.365 | 23 | 2.6 |
| | 3/18/2015 | 1.94 | 2.5 | 90 | 570 | < 0.2 | 110 | < 0.1 | < 0.50 | < 0.50 | < 0.50 | 5.69 | 14.62 | 0.498 | 63 | 3.3 |
| | 9/23/2015 | 0.67 | 0.51 | 71 | 970 | NA | 220 | < 0.1 | 3.0 | < 0.50 | < 0.50 | 5.65 | 17.86 | 0.406 | 49.6 | 2.7 |
| | 3/22/2016 | 0.61 | 3.4 | 88 | 490 | < 0.2 | 150 | < 0.1 | 1.4 | < 0.50 | < 0.50 | 5.89 | 14.08 | 0.503 | 66.1 | 3.2 |
| | 9/20/2016 | 0.23 | 0.30 | 59 | 15,000 | 1.5 | 340 | < 0.1 | 5.5 | < 0.50 | < 0.50 | 5.91 | 17.3 | 0.3953 | 68.4 | 4.0 |
| **Shallow Interval** | | | | | | | | | | | | | | | | |
| CI-7-40 | 3/25/2010 | 0.22 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 7.30 | 13.8 | 0.518 | -59.8 | NA |
| | 6/17/2010 | 0.6 | 5.1 | < 5 | 18,000 | 9.32 | 930 | NA | 8,200 | < 500 | < 500 | 6.90 | 15.2 | 0.378 | 101 | NA |
| | 9/30/2010 | 0.57 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.59 | 17.53 | 0.452 | -90.7 | NA |
| | 12/14/2010 | 4.37 | 0.05 | < 5 | 19,000 | NA | 670 | NA | 3,300 | < 500 | < 500 | 6.72 | 14.33 | 0.378 | 111.6 | NA |
| | 3/16/2011 | 2.25 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.70 | 13.61 | 0.483 | 81.8 | NA |
| | 5/4/2012 | 3.97 | NA | NA | 35,000 | NA | 720 | NA | NA | NA | NA | NA | 14.71 | 0.450 | 77.9 | NA |
| CI-8-40 | 3/24/2010 | 0.31 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.27 | 15.52 | 0.518 | -57 | NA |
| | 6/16/2010 | 0.81 | NA | NA | 29,000 | NA | 990 | NA | NA | NA | NA | 7.04 | 14.73 | 0.423 | 82.6 | NA |
| | 9/30/2010 | 0.80 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.86 | 15.77 | 0.508 | -114.4 | NA |
| | 12/16/2010 | 1.54 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.64 | 14.62 | 0.456 | 14.4 | NA |
| | 3/15/2011 | 0.77 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 7.84 | 14.01 | 0.551 | -26.6 | NA |
| | 9/29/2011 | 0.93 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.61 | 17.01 | 0.511 | -65.5 | NA |
| | 5/4/2012 | 0.42 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.47 | 14.79 | 0.555 | -58.1 | NA |

# Table 4
# Summary of Natural Attenuation and Water Quality Parameters
## West of 4th Group Site
## Capital Industries, Inc.
## 5801 3rd Avenue South
## Seattle, Washington
## Farallon PN: 457-008

| | | Electron Receptors | | | Total and Dissolved Metals | | | | Metabolic By-products | | | Water Quality Parameters [1] | | | | Available Organic Carbon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Location** | **Sample Date** | **Dissolved Oxygen [1] (mg/l)** | **Nitrate[2] (mg/l)** | **Sulfate[3] (mg/l)** | **Total Iron[4] (µg/l)** | **Ferrous Iron[5] (mg/l)** | **Total Manganese[4] (µg/l)** | **Manganese (II)[5] (mg/l)** | **Methane[6] (µg/l)** | **Ethane[6] (µg/l)** | **Ethene[6] (µg/l)** | **pH** | **Temperature (°Celsius)** | **Conductivity (mS/cm)** | **ORP (mV)** | **TOC[7] (mg/l)** |
| **Intermediate Interval** | | | | | | | | | | | | | | | | |
| CI-7-60 | 3/24/2010 | 0.36 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.48 | 16.36 | 0.699 | -70.5 | NA |
| | 6/17/2010 | 0.77 | 4.1 | 10 | 15,000 | 7.46 | 870 | NA | 7,700 | < 500 | < 500 | 7.15 | 14.54 | 0.472 | 91.9 | NA |
| | 9/30/2010 | 0.68 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.94 | 16.36 | 0.510 | -126 | NA |
| | 12/14/2010 | 5.23 | < 0.050 | 5.4 | 23,000 | NA | 850 | NA | 6,300 | < 500 | < 500 | 7.03 | 13.93 | 0.463 | 88.2 | NA |
| | 3/15/2011 | 4.96 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 7.06 | 13.79 | 0.597 | 62.1 | NA |
| | 5/4/2012 | 4.19 | NA | NA | 20,000 | NA | 860 | NA | NA | NA | NA | IE | 14.30 | 0.549 | 47.2 | NA |
| | 3/13/2013 | 0.58 | 0.58 | < 5.0 | 8,300 | 5 | 680 | < 0.1 | 6,200 | 1,400 | 1,500 | 6.59 | 13.71 | 0.516 | -58 | 3.7 |
| | 3/12/2014 | 0.62 | < 0.050 | < 5.0 | 8,600 | 1.6 | 700 | 0.1 | 4,000 | < 500 | < 500 | 6.69 | 14.65 | 0.595 | -56 | 4.2 |
| | 3/22/2016 | 1.14 | < 0.050 | < 5.0 | 8,700 | 2.0 | 670 | < 0.1 | 4,800 | < 250 | 1.0 | 6.63 | 14.12 | 0.568 | -65.6 | 4.8 |
| CI-8-60 | 3/24/2010 | 0.27 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 6.98 | 15.40 | 0.465 | -102.5 | NA |
| | 6/16/2010 | 0.63 | NA | NA | 6,900 | NA | 360 | NA | NA | NA | NA | 7.28 | 14.90 | 0.362 | 77.7 | NA |
| | 9/30/2010 | 0.51 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 7.14 | 15.87 | 0.418 | -141.6 | NA |
| | 12/16/2010 | 6.49 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 7.34 | 14.40 | 0.394 | 107.9 | NA |
| | 3/15/2011 | 0.21 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 8.02 | 13.77 | 0.503 | -67.2 | NA |
| | 3/18/2015 | 0.94 | NA | NA | NA | < 0.2 | NA | < 0.1 | NA | NA | NA | 6.76 | 14.95 | 0.507 | -88.2 | NA |
| | 3/22/2016 | 0.23 | NA | NA | NA | 2.0 | NA | < 0.1 | NA | NA | NA | 6.97 | 14.27 | 0.506 | -89.1 | NA |

NOTES:

< denotes analyte not detected at or exceeding the reporting limit listed.

[1] Collected using a YSI multiparameter meter with a flow-through cell.

[2] Analyzed by U.S. Environmental Protection Agency (EPA) Method 353.2.

[3] Analyzed by ASTM International Method D516-02 or D516-07.

[4] Analyzed by EPA Method 6010C.

[5] Measured in the field using conventional chemistry parameters by EPA/American Public Health Association Methods.

[6] Analyzed by EPA Method RSK-175.

[7] Analyzed by Standard Method 5310B.

° = degrees
electron receptors = compounds that gain electrons and are sources of energy during biodegradation
IE = instrument error
Intermediate Interval = groundwater collected from depths below 40 feet below ground surface
J = result is an estimate
metabolic by-products = compounds that result from biodegradation processes
µg/l = micrograms per liter
mg/l = milligrams per liter, equivalent to parts per million
mS/cm = milliSiemens per centimeter
mV = millivolts
NA= not analyzed
ORP = oxidation-reduction potential
Shallow Interval = groundwater collected from 20 to 40 feet below ground surface
TOC = total organic carbon
Water Table Interval = groundwater collected from first-encountered groundwater to 20 feet below ground surface

# APPENDIX A
# HEALTH AND SAFETY PLAN

REVISED CAPITAL INDUSTRIES PLANT 4 STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

# DRAFT HEALTH AND SAFETY PLAN

# REMEDIAL INVESTIGATION MONITORING, VAPOR MITIGATION SYSTEM OPERATIONS, AND CHEMICAL INJECTIONS
## CAPITAL INDUSTRIES, INC.
## 5801 3RD AVENUE SOUTH
## SEATTLE, WASHINGTON

**Submitted by:**
**Farallon Consulting, L.L.C.**
**975 5th Avenue Northwest**
**Issaquah, Washington 98027**

**Farallon PN: 457-007 and 457-008**

**For:**
**Mr. Ron Taylor**
**Capital Industries, Inc.**
**5801 Third Avenue South**
**Seattle, Washington 98108**

March 6, 2018

# HEALTH AND SAFETY PLAN
# REVIEW AND APPROVAL

**Client**: Capital Industries c/o Ron Taylor
**Facility Name**: Capital Industries, Inc.
**Type of Work**: Groundwater Monitoring, Operation and Maintenance, and Chemical Injection
**Project Number**: 457-007 and 457-008
**Start Date**: March 5, 2018
**End Date**: September 5, 2018

**Plan Expiration Date**: September 5, 2018 (Last day of expected field work or no longer than 6 months)

**APPROVED BY:**

Jennifer Moore
Project Manager

***Signature*** ***Date***

Joseph Rounds
Health and Safety Coordinator

***Signature*** ***Date***

Jeffrey Kaspar
Principal-in-Charge

***Signature*** ***Date***

This Health and Safety Plan (HASP) was written for the use of Farallon Consulting, L.L.C. (Farallon) and its employees. It may be used also by trained and experienced Farallon subcontractors as a guidance document. However, Farallon does not guarantee the health or safety of any person entering this site.

Due to the potentially hazardous nature of the site and the activities occurring thereon, it is not possible to discover, evaluate, or provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but does not eliminate, the potential for injury. The health and safety guidelines in this HASP were prepared specifically for this site, its conditions, purposes, dates of field work, and personnel, and must be amended if conditions change.

Farallon claims no responsibility for the use of this HASP by others. This HASP will provide useful information to subcontractors and will assist them in developing their own HASP, but it should not be construed as a substitute for their own HASP. Subcontractors should sign this HASP (see Attachment 1, *Health and Safety Plan Acknowledgment and Agreement Form*) as an acknowledgement of hazard information and as notice that this HASP does not satisfy their requirement to develop their own HASP.

# CONTENTS

## ATTACHMENTS

# 1.0 SITE-SPECIFIC INFORMATION

Information specifically pertaining to the project site, the scope of work for the project, and related safety concerns are discussed in this section.

## 1.1 BACKGROUND INFORMATION

Farallon Consulting, L.L.C. (Farallon) has prepared this Health and Safety Plan (HASP) for work being conducted on behalf of Capital Industries, Inc. (CI) at 5801 3rd Avenue South in Seattle, Washington. A remedial investigation (RI) was completed and approved by the Washington State Department of Ecology (Ecology) in December 2012. A feasibility study currently is being conducted on behalf of Art Brass Plating, Inc.; Blaser Die Casting Co.; CI; and PSC Environmental Services, LLC (collectively referred to herein as the West of 4th Group) in accordance with the requirements of Agreed Order No. DE 10402 entered into by the West of 4th Group and Ecology in April 2014. For the purposes of the RI and feasibility study, the Site is defined as the area south of South Mead Street, north of South Front Street, east of 1st Avenue South, and west of 4th Avenue South in Seattle, Washington. Ongoing work being conducted by Farallon at the Site includes:

- Semi-annual groundwater monitoring;
- Vapor intrusion monitoring at two properties proximate to the CI property (i.e., Olympic Medical Building at 5900 1st Avenue South, and Pacific Foods North and South Buildings at 5815 4th Avenue South);
- Operation and maintenance of vapor intrusion mitigation systems at the Olympic Medical Building and Pacific Foods North and South Buildings;
- Observation of subcontractors installing and maintaining monitoring wells on behalf of CI at CI Plant 4 and in other portions of the monitoring well network;
- Observation of in-situ chemical oxidation (ISCO) injection of a 3 percent potassium permanganate solution, which is proposed as an interim action at CI Plant 4; and
- Performance and compliance soil and groundwater monitoring associated with the interim action at CI Plant 4.

## 1.2 SCOPE OF WORK

This HASP was prepared for the use of Farallon personnel while performing the following tasks at the Site:

- **Groundwater Monitoring.** Farallon will perform semiannual groundwater monitoring and sampling across the Site. Farallon will also perform wellhead maintenance on those monitoring wells requiring repairs necessary to protect the well. The current scope of work can be referenced in the technical memorandum regarding FINAL West of 4th Groundwater Monitoring Program Plan 2017 through Draft Cleanup Action Plan, W4 Join Deliverable, Agreed Order No. DE 10402 dated March 21, 2017, from Ms. Janet Knox of Pacific Groundwater Group to Mr. Ed Jones of Ecology.
- **Vapor Intrusion Monitoring.** Farallon will conduct routine indoor and outdoor air sampling events at the Olympic Medical Building and the Pacific Foods North and South Buildings. This sampling includes inspections of the buildings to document current use and chemical products present, air sampling using Summa canisters, and data evaluation. Details of the monitoring work are presented in the technical memorandum regarding Revised Vapor Intrusion Assessment, Monitoring, and Mitigation Plan, W4 Joint Deliverable, Seattle, Washington dated February 2, 2015, from Farallon to Mr. Jones of Ecology.
- **Vapor Intrusion Mitigation System Operations and Maintenance.** Farallon periodically inspects and adjusts operation of two subslab depressurization systems at the Olympic Medical Building and the Pacific Foods North and South Buildings. Details of the monitoring work are presented in the technical memorandum regarding Revised Vapor Intrusion Assessment, Monitoring, and Mitigation Plan, W4 Joint Deliverable, Seattle, Washington dated February 2, 2015, from Farallon to Mr. Jones of Ecology.
- **Installation and Maintenance of Monitoring Wells.** Farallon will install five new semi-permanent, 1-inch-diameter monitoring wells in CI Plant 4 as a part of the performance and compliance monitoring program for the ISCO interim action. Farallon also may

perform some well maintenance and replacement activities to facilitate the semiannual groundwater monitoring program for the Site.

- **Chemical Oxidant Injection for Interim Action.** Farallon will observe ISCO injection of potassium permanganate into the vadose zone and Water Table Interval groundwater at CI Plant 4 as an interim action for the West of 4th Group. Stage 1 of the interim action includes an injectability study of the potassium permanganate injections at three locations to assess injection pressures, oxidant mixture, and radius of influence for the injection. Performance borings and groundwater monitoring events will be conducted after the Stage 1 injections to assess the effectiveness of the injections and refine Farallon's approach for the full-scale injection event, known as Stage 2. Stage 2 will be the full-scale injection event across most of CI Plant 4. Additional performance borings and groundwater monitoring events will follow the Stage 2 injections. This performance monitoring will help Farallon assess whether additional injections are necessary to remediate vadose zone soil and shallow groundwater. Ultimately, confirmation soil and groundwater monitoring will be conducted to demonstrate completion of the interim action and achievement of the interim action objectives. The scope of work for the interim action is explained in the *Draft Capital Industries Plant 4 Field Implementation Work Plan, West of 4th Group Site, Capital Industries, Inc., 5801 Third Avenue South, Seattle, Washington* dated March 6, 2018, prepared by Farallon.

## 1.3 SITE-SPECIFIC SAFETY CONCERNS

This phase of the project involves semiannual groundwater monitoring; monitoring well installation, repair, and replacement; vapor mitigation system operations and maintenance; and the ISCO interim action. Specific hazards that the field employee(s) will encounter on this project include, but are not limited to:

- Working around heavy equipment;
- Working with hand tools and small mechanical equipment;
- Pedestrian traffic;

- Truck traffic;
- Pinch points;
- Work exclusion zone safety;
- Slips, trips, and falls;
- Loud noise;
- The dangers of injecting a chemical oxidant at pressure into the subsurface;
- Chemical exposure related to soil and groundwater that is contaminated with chlorinated solvents; and
- Environmental hazards, including exposure to sun, heat, and cold.

Farallon and subcontractor personnel will be required to have 40-Hour Hazardous Waste Operations and Emergency Response training as hazardous waste operators in accordance with Part 1910.120 of Title 29 of the Code of Federal Regulations.

Skin and eye contact with oxidizing chemicals should be avoided, and special care should be taken to avoid breathing the chemicals in the form of dust or mist. Consequently, proper personal protective equipment (PPE) should be employed per the potassium permanganate safety data sheet (Attachment 10) and workers should handle the chemicals in a manner that minimizes the creation of mist or dust. Proper respiratory, eye, face, and skin protection should always be worn when working directly with these chemicals.

A safety meeting will be held prior to each injection to discuss specific concerns for each ISCO injection location. The depth interval, desired flow rate, and desired injection pressure will be discussed. The location of spill kits necessary to neutralize, contain, and recover permanganate that could surface will be discussed. The location of underground utilities and other underground structures near the injection point will be identified, clearly marked, and discussed. Sudden changes in injection rates and pressure are usually the first sign of surfacing during pressurized ISCO injection. If the oxidant surfaces, the injection will be stopped immediately. The spill kit will be mobilized to contain and neutralize the spill. If necessary, a large amount of water may be used to dilute the potassium permanganate to safe levels. The liquid will be recovered, containerized, and disposed of in accordance with applicable federal, state, and local laws. A follow-up meeting will be held to discuss the surfacing, when it happened, why it happened, and what actions can be taken to prevent it from happening again. The injection point and surfacing location will be sealed with bentonite before switching to a new injection location. Injection pressures and flowrates will be adjusted to prevent future surfacing.

The following precautions are being taken by Cascade Environmental, which will perform the oxidant injections:

- A few gallons of neutralizer solution will be on hand to help address any small spills or surfacing of the oxidant during injection;
- Any nearby floor or stormwater drains will be covered or blocked by absorbent socks;
- The totes of oxidant solution will be kept within secondary containment;
- All staff in the exclusion zone will don Tyvek and face shields plus standard PPE;
- Whip checks are present on all pressurized hose connections; and
- Constant pressure monitoring during injection of the oxidant.

# 2.0 DRUG AND ALCOHOL POLICY

It is Farallon's policy to maintain a drug-free workplace. Farallon has a responsibility to all of its staff members to provide a safe and inoffensive work environment, and a responsibility to its clients to provide accurate and consistent service. For these reasons, Farallon prohibits the following behavior by staff members in the field:

- Use of tobacco in any form by any person at any time in sensitive or hazardous areas that may pose a health and safety or environmental risk. The Site Health and Safety Officer (SHSO) may designate an area away from hazards that is safe for tobacco use.
- Possession or consumption of alcohol and/or marijuana, or being under the influence of alcohol and/or marijuana during field activities.
- Abuse of prescription and/or over-the-counter drugs in such a manner as to negatively impact performance or field safety.
- Possession, use, sale, or being under the influence of illicit drugs while in the field or during any work hours.

Violation of any of the above codes of conduct is grounds for immediate removal from the project Site and discipline in accordance with Farallon company policy. If an incident occurs as a result of an employee's actions, drug and alcohol testing will be performed in accordance with Farallon company policy.

# 3.0 WEAPONS POLICY

Farallon employees, contractors, subcontractors, and their employees working at the Site are to ensure that they do not bring weapons onto the work site. Weapons include but are not limited to guns, knives, and explosives. Tools that are used during the course of field events, including but not limited to box knives, are exempt from this weapons policy. All vehicles and persons can be subjected to search while working at the property.

Failure to comply with the weapons policy can result in disciplinary action for the individual(s) involved in accordance with Farallon company policy.

# 4.0 INCIDENT PREPAREDNESS AND RESPONSE

Farallon employees and subcontractors working at the Site must be prepared to respond appropriately to an incident involving injury, illness, death, spills, or utility breaches. This section outlines the degree of preparedness required for employees at a work site, and describes the actions to be taken in the event of a health and safety incident.

## 4.1 HEALTH AND SAFETY PREPAREDNESS

All individuals working at the Site are required to be familiar with the contents of this HASP. Additionally, the items on the following health and safety preparedness list should be reviewed prior to the commencement of work and during daily health and safety meetings:

- The directions to the hospital (provided in Attachment 2);
- The locations of first aid kits, personal eye washes, and fire extinguishers (located in Site vehicles);
- The locations of the keys to Site vehicles; and
- Hand sign language providing for the immediate stoppage of work (such as a horizontal hand movement in front of the neck).

Additional topics for daily health and safety meetings are included in Attachment 3, Potential Topics for Daily Health and Safety Meeting. Participation in daily health and safety meetings should be documented in Attachment 4, Daily Health and Safety Briefing Log.

## 4.2 INJURY OR ILLNESS

If an injury or illness occurs, the following actions should be taken, regardless of the severity of the injury or illness:

- Stop work.
- Determine whether emergency response staff (e.g., fire, ambulance) are necessary. If so, dial 911 on a cell phone or the closest available telephone. Describe the location of the

injured person and provide other details as requested. If an individual requires non-emergency medical care at a hospital, follow the directions to the nearest hospital, which are provided in Attachment 2. IF EMERGENCY MEDICAL CARE IS NEEDED, CALL 911.

- Administer first aid to the individual immediately, using the first aid kit provided in the Site vehicle. Use the bloodborne pathogens kit and personal eyewash, as needed.
- Notify the SHSO immediately. The SHSO is responsible for preparing and submitting an Incident Report form to Farallon’s Health and Safety Coordinator (HSC) within 24 hours of the incident, and for notifying the employee's supervisor and the Principal-in-Charge. The Incident Report form is provided in Attachment 5.
- ***All incidents must be reported to the HSC within 24 hours; however, the actual investigation need not be completed within 24 hours*. A telephone message that includes the date, time, and general incident circumstances should be left at one of the following numbers if the HSC cannot be reached directly**:
    - HSC work phone: (425) 295-0800
    - HSC cell phone: (206) 484-2748
    - If the HSC cannot be located, contact the Principal-in-Charge
- The SHSO will assume responsibility during a medical emergency until emergency response personnel arrive at the Site.

## 4.3 REPORTING PROCEDURES FOR MINOR CUTS, SCRATCHES, BRUISES, ETC.

Every occupational illness or injury is to be reported immediately by the employee to the SHSO. The SHSO is to complete the Incident Report form provided in Attachment 5, and report the incident to the HSC.

## 4.4 NEAR MISSES

A near miss is defined as an incident in which no personal injury is sustained and no property damage is incurred, but in which injury and/or property damage could have occurred under slightly different timing or location.

In the event of a near miss, the following actions are to be taken:

- Stop work if there is immediate danger of injury or property damage;
- Report the near miss to the SHSO as soon as practicable;
- Resume work upon satisfactory resolution of the near-miss condition, if work was stopped, and document the corrective action(s) taken by the SHSO; and
- Complete and submit the Near Miss Report form in Attachment 6 to the HSC within 2 business days.

## 4.5 MEDICAL INCIDENTS NOT REQUIRING AMBULANCE SERVICE

Medical incidents not requiring ambulance services include injuries and conditions such as minor lacerations and sprains. In the event of an injury, an illness, or a condition that does not require ambulance service, the following actions are to be taken:

- Stop work.
- Administer first aid as necessary to stabilize the individual for transport to the hospital.
- The SHSO is to facilitate prompt transportation of the individual to the hospital. Directions to the nearest hospital are provided in Attachment 2.
- A representative of Farallon or the subcontractor is to drive the individual to the medical facility and remain at the facility until the individual is able to return to the work site, or arrangements for further care have been established.
- If the driver is not familiar with the route to the hospital, a second person who is familiar with the route is to accompany the driver and the injured employee to the hospital.

- If it is necessary for the SHSO to accompany the injured employee to a medical facility, provisions must be made for another employee who is trained and certified in first aid to act as the temporary SHSO before work at the work site can resume.
- If the injured employee is able to return to the work site the same day, he/she is to bring a statement from the doctor that provides the following information:
    - Date of incident
    - Employee's name
    - Diagnosis
    - Date he/she is able to return to work, and whether regular or light duty
    - Date he/she is to return to the doctor for a follow-up appointment, if necessary
    - Signature and address of doctor
- The SHSO is to complete the Incident Report form provided in Attachment 5, and report the incident to the HSC.
- If the injured employee is unable to return to the work site the same day, the employee who transported him/her should bring the statement from the doctor back to the work site. The information on this statement should be reported to the HSC immediately.

## 4.6 EMERGENCY CASES REQUIRING AMBULANCE SERVICE

In the event of an injury or illness that requires emergency response and transport to a hospital by ambulance the following actions should be taken:

- **Dial 911** to request ambulance service;
- Notify the SHSO;
- Administer first aid until the ambulance service arrives;

- One designated company representative should accompany the injured employee to the medical facility and remain there until final diagnosis, treatment plan, and other relevant information has been obtained; and
- The SHSO is to complete the Incident Report form provided in Attachment 5, and report the incident to the HSC immediately.

## 4.7 EMPLOYEE DEATH, OR HOSPITALIZATION OF ONE OR MORE EMPLOYEES

The procedures outlined in Section 6.2 should be followed in the event of an employee injury or illness. If an employee fatality occurs, the HSC, local emergency personnel, and the coroner must be notified **immediately**. **The HSC will initiate the required State of Washington Department of Labor and Industries and Occupational Safety and Health Administration (OSHA) notifications within 8 hours of a fatality or the hospitalization of one or more employees.**

## 4.8 RESPONSE TO SPILLS OR UTILITY BREACHES

The location of underground utilities (e.g., product, sewer, telephone, fiber optic) and facilities (e.g., underground storage tanks, septic tanks, utility vaults) is to be noted prior to commencement of intrusive subsurface work activities. Use the public and private locate services as required and complete the Utility Clearance Log (Attachment 7). If a utility line or tank is breached or a spill or release occurs, the event is to be documented on the Incident Report form provided in Attachment 5 as soon as possible. The date, time, name of the person(s) involved, actions taken, and discussions with other affected parties are to be included. The SHSO, Project Manager (PM), and client are to be notified immediately. The PM is to notify the regulatory authority and/or utility company, as necessary.

In the event of a spill or release, the following actions should be taken:

- Stay upwind of the spill or release.
- Don appropriate PPE.
- Turn off equipment and other sources of ignition.

- Turn off pumps and shut valves to stop the flow or leak.
- Plug the leak or collect drippings, if possible.
- Use sorbent pads to collect the product and impede its flow, if possible.
- Dial 911 or telephone the local fire department immediately if a fire or another emergency situation develops.
- Inform the Farallon PM of the situation.
- Determine whether the client would like Farallon to repair the damage or would rather use an emergency repair contractor.
- Advise the client of spill discharge notification requirements, and establish who will complete and submit the required forms. ***Do not report or submit information to an agency without the client's consent.*** Document each interaction with the client and regulators, and note in writing names, titles, authorizations, refusals, decisions, and commitments to any action.
- Do not transport or approve transportation of contaminated soils or product until proper manifests have been completed and approved. Be aware that soil and/or product may meet criteria for hazardous waste.
- Do not sign manifests as a generator of wastes. Contact the PM to discuss waste transportation.

## 4.9 NOTIFICATIONS

A spill or release requires completion of an Incident Report form (provided in Attachment 5) per Farallon's Health and Safety program. **The PM must involve the client and/or generator in the incident reporting process. The client and/or generator is under obligation to report the incident to the appropriate government agency(ies). If the spill extends into waterways, the Coast Guard and the National Response Center must be notified immediately by the client or with client permission (1-800-424-8802).**

## 4.10 SHUTOFF VALVES AND/OR SWITCHES FOR UTILITIES AND PRODUCTS

Before starting work, locate, discuss, and list on the Daily Health and Safety Briefing Log the locations of utility and product line shutoff valves and switches on the work site. Review the location of shutoff valves and switches with other field personnel before beginning work.

# 5.0 EMERGENCY RESPONSE AND EVACUATION PLAN

Farallon personnel and subcontractors working on the Site are to be aware of Site-specific emergency and evacuation procedures, including alarm systems and evacuation plans and routes. If an incident occurs that requires emergency response, such as a fire or spill, **CALL 911 and request assistance**. Farallon staff, subcontractors, and/or others working in an area where an emergency occurs are to evacuate to a safe location away from the incident area, preferably upwind, and take attendance.

**For this project, the emergency evacuation gathering location is the sidewalk at the intersection of South Mead Street and 3$^{rd}$ Avenue South (see yellow star on figure below).**

If the emergency causes the route to be obstructed, Farallon personnel and subcontractors are to move to an open area upwind of the hazard area, and remain there until instructed by emergency response personnel (e.g., police, fire, ambulance personnel, paramedics) to do otherwise.

Subcontractors have the responsibility to account for their own employees and provide requested information to emergency response personnel immediately upon request. Farallon staff, subcontractors, and/or contractors may not reenter the scene of the emergency without specific approval from emergency response personnel.


S Orcas St
S Orcas St
Aki Bakery
S Orcas St
S Mead St
S Mead St
S Mead St
E Marginal Way S
1st Avenue South
Capital Industries, Inc
S Fidalgo St
S Fidalgo St
S Fidalgo St
2nd Ave S
4th Ave S
4th Ave S
Jack in the Box
Chevron

# 6.0 LOCAL EMERGENCY CONTACT NAMES AND TELEPHONE NUMBERS

Local emergency response personnel can be contacted at the following numbers. Directions and a map to the hospital are included in Attachment 2.

| **Emergency Contact** | **Name and Location** | **Telephone No.** |
|---|---|---|
| **Hospital** | Swedish Cherry Hill Campus<br>500 17th Avenue<br>Seattle, Washington 98122 | (206) 320-2000 |
| **Police** | Seattle Police Department South Precinct<br>3001 South Myrtle Street<br>Seattle, Washington 98108 | **911** or<br>(206) 386-1850 |
| **Fire** | Seattle Fire Department, Station 27<br>1000 South Myrtle Street<br>Seattle, Washington 98108 | **911** |
| **National Response Center** | | **1-800-424-8802** |
| **Washington State Department of Ecology** | | **(360) 407-6300** |
| **Poison Control** | | **1-800-222-1222** |

# 7.0 PROJECT PERSONNEL AND RELEVANT INFORMATION

The following section provides contact information for the project and the HSC and client-specific health and safety requirements. Farallon field personnel training and medical surveillance dates are included in Attachment 8.

## 7.1 PROJECT PERSONNEL CONTACT INFORMATION

Questions about this project that are posed by neighbors, the press, or other interested parties should be directed to the Principal-in-Charge at Farallon: (425) 295-0800.

| PERSONNEL TITLE PERSONNEL NAME PERSONNEL CONTACT INFORMATION | GENERAL PROJECT RESPONSIBILITIES |
|---|---|
| **Health and Safety Coordinator**<br>Joseph Rounds<br>Office: (425) 295-0800<br>Cell: (206) 484-2748 | Provide support in implementing HASP. Provide immediate support upon notice of any incident. |
| **Principal-in-Charge**<br>Jeff Kaspar<br>Office: (425) 295-0800<br>Cell: (425) 765-3366 | Provide immediate support upon notice of any incident. |
| **PROJECT MANAGER**<br>Jennifer Moore<br>Office: (425) 295-0800<br>Cell: (425) 417-7238 | Provide immediate support upon notice of any incident. |
| **Client Contact**<br>Ron Taylor<br>Office: (206) 765-8585 | Provide known analytical data from work performed by others. Provide notice of Site hazards. Provide access to Site. Provide information regarding available emergency supplies at the Site. |

# 8.0 POTENTIAL CHEMICAL EXPOSURE

Farallon employees working at the Site may become exposed to the chemicals listed in the table below. These chemicals are present either due to current Site activities or due to the presence of contamination. This table should be reviewed prior to the start of work and questions directed to the SHSO. Air monitoring may be required at the Site based on the scope of work for the project. The Farallon Project Manager and SHSO will let the Farallon Field Scientists know if air monitoring will be required for the scope of work.

The air monitoring table and forms are included in Attachment 9.

| **POTENTIALCHEMICALS ON SITE FOR THIS PROJECT REVIEW THIS TABLE AND CONTACT THE SHSO WITH ANY QUESTIONS** | | | | | | |
|---|---|---|---|---|---|---|
| **Chemical (or Class)** | **OSHA PEL ACGIH TLV** | **Other Pertinent Limits** | **Properties** | **Routes of Exposure or Irritation** | **Acute Health Effects** | **Chronic Health Effects/ Target Organs** |
| Potassium Permanganate | No PEL or TLV | STEL 3 mg/m$^3$<br>TWA 1 mg/m$^3$ | Dark purple, odorless powder. Will be mixed with water to form a 3 percent solution. | Inhalation, eye, and skin irritant. Use respirator with particulate cartridge, safety glasses with face shield, and chemical protective clothing and gloves. | Can cause breathing difficulty and eye and skin irritation. | Eyes |
| 1,2-Dichloroethene (dichloroethylene) | PEL - TWA 200 ppm<br>TLV - TWA 200 ppm | IDLH - 1000 ppm | Solvent odor. | Inhalation; skin absorption; ingestion; eye contact. | Typical solvent symptoms. | Liver, kidney, CNS symptoms. |

| POTENTIALCHEMICALS ON SITE FOR THIS PROJECT<br>REVIEW THIS TABLE AND CONTACT THE SHSO WITH ANY QUESTIONS | | | | | | |
|---|---|---|---|---|---|---|
| **Chemical (or Class)** | **OSHA PEL ACGIH TLV** | **Other Pertinent Limits** | **Properties** | **Routes of Exposure or Irritation** | **Acute Health Effects** | **Chronic Health Effects/ Target Organs** |
| 1,1-Dichloroethene (vinylidene chloride) | No PEL<br>TLV – 5 ppm | NIOSH considers this compound to be a carcinogen. | Colorless liquid or gas (above 89°F) with a mild, sweet, chloroform-like odor. | Inhalation; skin absorption; ingestion; eye contact. | Irritation to eyes, skin, throat; dizziness; headache; nausea; dyspnea (breathing difficulty). | Liver, kidney dysfunction; pneumonitis; potential occupational liver and kidney carcinogen. **Target Organs:** Eyes, skin, respiratory system, CNS, liver, kidneys. |
| Tetrachloroethene (perchloroethylene) | PEL - 100 ppm<br>TLV - 25 ppm | PEL Ceiling - 200 ppm<br>TLV STEL - 100 ppm<br>IDLH - 150 ppm<br>NIOSH considers this compound to be a carcinogen. | Colorless liquid with a mild, chloroform-like odor. | Inhalation; skin absorption; ingestion; eye contact. | Irritation to eyes, skin, nose, throat, respiratory system; nausea; flushed face, neck; vertigo (an illusion of movement); dizziness; lack of coordination; headache; skin erythema (redness). | Somnolence (sleepiness, unnatural drowsiness); liver damage; potential occupational liver carcinogen. **Target Organs:** Eyes, skin, respiratory system, liver, kidneys, CNS. |
| Vinyl chloride | PEL - 1 ppm<br>TLV - 1 ppm | NIOSH considers this material to be a carcinogen. | Liquid with a pleasant odor at high concentrations. | Inhalation; dermal; eye contact. | Weakness; abdominal pain; pallor or cyanosis of extremities; liquid frostbite. | Gastrointestinal bleeding; enlarged liver; potential occupational liver carcinogen; damage to CNS, blood, respiratory system, lymphatic system. |
| Trichloroethene (trichloroethylene) | PEL - 100 ppm<br>TLV - 50 ppm | PEL Ceiling - 200 ppm<br>NIOSH considers trichloroethylene to be a carcinogen. | Colorless liquid (unless dyed blue) with a chloroform-like odor. | Inhalation; dermal; ingestion; eye contact. | Irritation to eyes, skin; headache; vertigo (an illusion of movement); visual disturbance; fatigue; giddiness; tremor; somnolence (sleepiness, unnatural drowsiness); nausea; vomiting; dermatitis. | Cardiac arrhythmias; paresthesia; liver injury; potential occupational carcinogen of liver, kidney. |

NOTES:
°F = degrees Fahrenheit
ACGIH = American Conference of Governmental Industrial Hygienists
AIHA = American Industrial Hygiene Association
AIHA WEEL = AIHA-set workplace environmental exposure limits
C = ceiling limit
CNS = central nervous system
CVS = cardiovascular system
IDLH = immediately dangerous to life or health
mg/m$^3$ = milligrams per cubic meter
NIOSH = National Institute for Occupation Safety and Health
OSHA = Occupation Safety and Health Administration
PEL = permissible exposure limit
ppm = parts per million
RBC = red blood cells
REL = recommended exposure limit set by NIOSH
Skin = skin absorption
STEL = short-term exposure limit
TLV = threshold limit value set by ACGIH
TWA = time-weighted average

## 9.0 POTENTIAL SITE HAZARDS AND APPROPRIATE PRECAUTIONS

Activities listed may be associated with work performed by others. The information contained in this section is for the use of Farallon personnel and not intended for use by others. The following tables list potential hazards and appropriate precautions associated with planned field work.

The following are a few basic guidelines to remember while performing field work at the Site:

- No eating, drinking, or smoking on the Site;
- No wearing contact lenses on the Site;
- No facial hair that will interfere with proper respirator fit when respirators are required; and
- A safety meeting will be held every day, even if only one person is working on the project on a given day.

## 9.1 ENVIRONMENTAL DRILLING

| Job Steps | Personal Protective Equipment | Potential Hazards | Critical Actions |
|---|---|---|---|
| Clear drilling locations. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, and work gloves. | Traffic hazards.<br>Overhead or underground installations.<br>Product releases.<br>Property damage.<br>Occupant inconvenience. | • Refer to Utility Clearance Log (**Attachment 7**).<br>• Coordinate with Site Manger (or designee) to minimize potential conflicts.<br>• Review proposed locations against available construction drawings and known utilities, tanks, product lines, etc.<br>• Mark out the proposed borehole locations.<br>• Call underground utility locating service for public line location clearance and obtain a list of utilities being contacted. If necessary, coordinate private line locator for private property.<br>• Develop a traffic control plan with the client and local agencies, as applicable, which may include use of cones, barrier tape, jersey barriers, etc. |
| Mobilize with equipment/supplies suitable for drilling. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, and work gloves. | Vehicle accident.<br>Lifting hazards.<br>Delay or improper performance of work due to improper equipment on Site. | • Begin each work day with tailgate safety meeting.<br>• Follow safe driving procedures.<br>• Employ safe lifting procedures.<br>• Verify that subcontractors are aware of their responsibilities for labor, equipment, and supplies.<br>• Review permit conditions. |
| Visually clear proposed drilling locations. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, and work gloves. | Underground or overhead installations. | • Complete Utilities and Structures checklist on the Utility Clearance Log (provided in **Attachment 7**) and adjust drilling locations as necessary. |

| Job Steps | Personal Protective Equipment | Potential Hazards | Critical Actions |
|---|---|---|---|
| Set up necessary traffic control. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, and work gloves. | Struck by vehicle during placement.<br>Vehicle accident resulting from improper placement of traffic control equipment. | • Use buddy system for implementing traffic control plan, such as setting out cones and tape to define the safety area. |
| Assist with setup of rig. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, and work gloves. | Vehicle accident during rig movement.<br>Damage caused by rig while accessing set-up location.<br>Contact with overhead installations.<br>Soft terrain.<br>Unexpected rig movement. | • All staff should know the location of the kill switch for the drilling rig.<br>• Verify a clear pathway to the drilling location and clearance for raising mast.<br>• Provide hand signals and guidance to the driver, as needed, to place rig.<br>• Visually inspect rig (e.g., fire extinguisher on board, no oil or other fluid leaks, cabling and associated equipment in good condition, pressurized hoses secured with whip-checks or adequate substitute, jacks in good condition).<br>• Use wooden blocks under jacks to spread load, if necessary. Chock wheels. |
| Set up exclusion zone(s) and work stations (drilling and logging and/or sample collection). | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, and work gloves. | Struck by vehicle during setup.<br>Slip or fall hazards. | • Implement exclusion zone setup. Set up work stations with clear walking paths to and from rig. Use safety tape and cone(s). |

| Job Steps | Personal Protective Equipment | Potential Hazards | Critical Actions |
|---|---|---|---|
| Clear upper 5 feet of drilling location using post-hole digger or hand auger. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, and work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, and chemical-resistant apron as required. | Back strain.<br>Exposure to chemical hazards.<br>Hitting an underground utility.<br>Repetitive motion. | • Keep full-face respirator with organic vapor cartridges readily accessible.<br>• Initiate air quality monitoring in accordance with the air monitoring protocol presented in **Attachment 9**.<br>• Stand upwind to avoid exposure when possible.<br>• Use the organic vapor monitor aggressively to track the airborne concentration of contaminants close to potential sources such as the core when it is raised from the hole, the core when opened, etc.<br>• Evaluate any soil samples inside a resealable plastic bag at arm's length. DO NOT EVALUATE THE SAMPLE IN THE OPEN, IN ORDER TO AVOID UNNECESSARY EXPOSURE.<br>• Use correct lifting techniques and tools.<br>• Complete the Pre-Drilling section of the Borehole Clearance Review form. |
| Drilling. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Back strain.<br>Heat or cold.<br>Eye injury.<br>Noise.<br>Exposure to chemical hazards.<br>Breaching an underground utility.<br>Trip or fall.<br>Equipment failure. | • Stand clear of operating equipment.<br>• Use correct lifting techniques.<br>• Monitor air quality in accordance with the air monitoring protocol presented in **Attachment 9**.<br>• Monitor drilling progress.<br>• Keep work area clear of tripping or slipping hazards.<br>• Perform periodic visual inspections of drill rig. |

| Job Steps | Personal Protective Equipment | Potential Hazards | Critical Actions |
|---|---|---|---|
| Collect samples in accordance with sampling plan. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Back strain.<br>Heat or cold.<br>Eye injury.<br>Noise.<br>Exposure to chemical hazards.<br>Breaching an underground utility.<br>Trip or fall.<br>Equipment failure. | • Stand clear of operating equipment.<br>• Use correct lifting techniques.<br>• Monitor air quality in accordance with the air monitoring protocol presented in **Attachment 9**.<br>• Monitor drilling progress.<br>• Keep work area clear of tripping or slipping hazards.<br>• Perform periodic visual inspections of drill rig. |
| Manage cuttings. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Back strain.<br>Heat or cold.<br>Eye injury.<br>Noise.<br>Exposure to chemical hazards.<br>Breaching an underground utility.<br>Trip or fall.<br>Equipment failure. | • Stand clear of operating equipment.<br>• Use correct lifting techniques.<br>• Monitor air quality in accordance with the air monitoring protocol presented in **Attachment 9**.<br>• Monitor drilling progress.<br>• Keep work area clear of tripping or slipping hazards.<br>• Perform periodic visual inspections of drill rig. |

| Job Steps | Personal Protective Equipment | Potential Hazards | Critical Actions |
|---|---|---|---|
| Backfill borehole. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Back strain.<br>Trip hazards.<br>Eye injury from splashing or release of pressurized grout. | • Mix grout to specification and completely fill the hole.<br>• Use proper lifting techniques.<br>• Keep work area clear of tripping hazards.<br>• Verify presence of and/or authorization by required grouting inspectors. |
| Develop well. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Physical injury from mechanical failure, drill rig, or air compressor.<br>Trip hazards.<br>Exposure to contaminants.<br>Electric shock. | • Verify that equipment is in good working order and that pressurized hoses are whip-checked.<br>• Keep full-face respirator with organic cartridges readily accessible.<br>• Keep work area orderly.<br>• Any generators must be equipped with a ground fault circuit interrupter (GFCI). |
| Gauge water levels and product thickness in wells, where applicable. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Back strain.<br>Inhalation or dermal exposure to chemical hazards.<br>Repetitive motion. | • Have full-face respirator with organic cartridges readily accessible.<br>• Conduct air quality monitoring in accordance with the protocol presented in **Attachment 9.**<br>• Maintain a safe distance from the well head.<br>• Bend at knees rather than at the waist. |
| Purge well(s) and collect purge water. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Back strain.<br>Inhalation or dermal exposure to chemical hazards.<br>Slip or fall.<br>Contaminated water spill. | • Use proper lifting techniques.<br>• Use PPE, and adhere to air monitoring guidelines as presented in **Attachment 9**.<br>• Keep work area clear of tripping or slipping hazards.<br>• Store purge water in appropriate containers. |

| Job Steps | Personal Protective Equipment | Potential Hazards | Critical Actions |
|---|---|---|---|
| Collect groundwater samples in accordance with sampling plan. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Cross-contamination.<br>Back strain.<br>Inhalation or dermal exposure to chemical hazards.<br>Slip or fall.<br>Improper labeling or storage of samples.<br>Injury from broken sample bottle (cuts or acid burns). | • Decontaminate sampling equipment between each well (unless disposable).<br>• Use proper lifting techniques.<br>• Have full-face respirator with organic cartridges within 3 to 5 feet of working location, and readily accessible.<br>• Label samples in accordance with sampling plan.<br>• Keep samples stored in appropriate containers, at correct temperature, and away from work area.<br>• Handle bottles carefully. |
| Dispose of or store any purge water on the Site. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Back strain.<br>Exposure to contaminants. | • Use suitable equipment to transport water (e.g., pumps, drum dollies).<br>• Have full-face respirator with organic cartridges within 3 to 5 feet of working location, and readily accessible.<br>• Label storage containers properly, and locate in an isolated area away from traffic and other Site functions.<br>• Coordinate off-Site disposal (where applicable). |
| Clean the Site; demobilize. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Traffic.<br>Lifting hazards. | • Use buddy system to remove traffic control, as necessary.<br>• Leave the Site clear of refuse and debris.<br>• Clearly mark or barricade any borings that need topping off or curing at a later time.<br>• Notify Site personnel of departure, final well locations, and any cuttings and/or purge water left on the Site.<br>• Use proper lifting techniques. |

| Job Steps | Personal Protective Equipment | Potential Hazards | Critical Actions |
|---|---|---|---|
| Package and deliver samples to laboratory. | | Back strain.<br>Traffic accidents. | - Handle and pack bottles carefully (e.g., bubble wrap bags).<br>- Use proper lifting techniques.<br>- Apply safe driving practices. |
| Typical work. | Steel-toed and -shank shoes, hard hat, safety glasses with side shields, hearing protection, reflective safety vest, leather gloves for non-chemical aspects of work.<br>Chemical-resistant gloves and apron if chemical exposure is suspected. | Weather-related incidents: automobile accidents, slips or falls. | - Check weather reports daily. Project visits are not to be performed during inclement weather. Sampling may be performed during light rain mist. Wear raincoats.<br>- Drive at speed limit or less, as needed, to keep a safe distance from vehicle in front. Avoid short stops. |
| Typical work. | | Cold stress. | - For temperatures below 40°F, adequate insulating clothing must be worn. If the temperature is below 20°F, workers will be allowed to enter a heated shelter at regular intervals. Warm, sweet drinks should be available. Coffee intake should be limited.<br>- No one should begin work or return to work from a heated shelter with wet clothes.<br>- Workers should be aware of signs of cold stress, such as heavy shivering, pain in fingers or toes, drowsiness, or irritability. Onset of any of these signs is an indication that immediate return to a heated shelter is needed.<br>- Refer to ACGIH TLV Booklet for the section on Cold Stress. |

| Job Steps | Personal Protective Equipment | Potential Hazards | Critical Actions |
|---|---|---|---|
| Typical work. |  | Heat stress. | • Discuss health effects and symptoms during daily health and safety meetings.<br>• Drink water regularly (at least one cup every 20 to 30 minutes, depending upon level of effort and the PPE worn).<br>• Refer to ACGIH TLV booklet for heat stress guidance, especially regarding PPE, type of work, and frequency of breaks.<br>• Breaks should be taken in an area cooler than the work area.<br>• Monitor temperature and relative humidity using a wetbulb globe temperature (WBGT) meter. |
| A safety meeting will be held every day, even if only one person is working on the project on a given day. |  |  | • Topics are to always include the work scheduled for the day and restatement of hazards and the means to avoid them. Other topics may include sampling in general, and advances in technology and how they may be applied to the project.<br>• Use the *Daily Health and Safety Briefing Log* in **Attachment 4** to log the topics discussed. |

## 9.2 MONITORING WELL SAMPLING/GAUGING

| Job Steps | Personal Protective Equipment | Potential Hazard | Critical Actions |
|---|---|---|---|
| Mobilize with equipment/supplies suitable for sampling. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves. | Vehicle accident.<br>Lifting hazards.<br>Delay or unsafe performance of work due to lack of necessary equipment on Site.<br>Cross-contamination of wells. | • Follow safe driving procedures.<br>• Use proper lifting techniques.<br>• Review work plan to determine equipment/supply needs.<br>• Verify that all sampling/gauging equipment has been decontaminated.<br>• Bring ice for sample storage.<br>• Review the HASP.<br>• Gather the necessary PPE. |
| Set up necessary traffic control. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves. | Struck by vehicle during placement.<br>Vehicle accident as a result of improper traffic-control equipment placement. | • Use buddy system for placing traffic control. Refer to the traffic control plan section of the HASP (which may include specific requirements based on encroachment permit). |
| Set up exclusion zone(s). | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves. | Struck by vehicle.<br>Slip or fall hazards to workers. | • Face incoming traffic.<br>• Implement exclusion zone setup instructions of the HASP (e.g., barricades, caution tape, cones).<br>• Set up work area free of trip hazards. |
| Gauge water levels and product thickness (where applicable) in wells. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Back strain.<br>Inhalation of, or dermal exposure to, chemical hazards.<br>Repetitive motion. | • Wear required PPE.<br>• Initiate air quality monitoring in accordance with the HASP.<br>• Maintain a safe distance from wellhead.<br>• Bend at knees rather than at waist. |

| Job Steps | Personal Protective Equipment | Potential Hazard | Critical Actions |
|---|---|---|---|
| Purge well(s) and collect purge water. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Cross-contamination.<br>Back strain.<br>Inhalation of, or dermal exposure to, chemical hazards.<br>Slip or fall.<br>Contaminated water spill. | • Decontaminate purging equipment between each sampling location.<br>• Use proper lifting techniques.<br>• Use PPE and conduct monitoring in accordance with the HASP.<br>• Keep work area clear of tripping or slipping hazards.<br>• Store purge water in appropriate containers. |
| Collect samples in accordance with sampling plan. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Cross-contamination.<br>Back strain.<br>Inhalation of, or dermal exposure to, chemical hazards.<br>Slip or fall.<br>Improper labeling or storage.<br>Injury from broken sample bottle (e.g., cut or acid burn). | • Decontaminate sampling equipment between each well (unless disposable equipment).<br>• Use proper lifting techniques.<br>• Use PPE in accordance with the HASP.<br>• Label samples in accordance with sampling plan.<br>• Keep samples stored in suitable containers, at correct temperature, and away from work area.<br>• Handle bottles carefully. |
| Dispose of or store purge water on the Site. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Back strain.<br>Exposure to contaminants.<br>Damage or injury from improper use of on-Site treatment system equipment.<br>Improper storage or disposal. | • Use suitable equipment to transport water (e.g., pumps, drum dollies).<br>• Wear PPE in accordance with the HASP.<br>• Review any necessary instructions for use of on-Site treatment systems.<br>• Label storage containers properly and locate in an isolated area away from traffic and other Site functions.<br>• Coordinate off-Site disposal, where applicable. |

| Job Steps | Personal Protective Equipment | Potential Hazard | Critical Actions |
|---|---|---|---|
| Clean the Site; demobilize. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves. | Traffic.<br>Safety hazard left on the Site.<br>Lifting hazard. | • Use buddy system to remove traffic control, as necessary.<br>• Leave the Site clear of refuse and debris.<br>• Notify business personnel of departure, and of any purge water left on the Site.<br>• Use proper lifting techniques. |
| Package and deliver samples to laboratory. | | Bottle breakage.<br>Back strain. | • Handle and pack bottles carefully (e.g., bubble wrap bags).<br>• Use proper lifting techniques. |

## 9.3 CHEMICAL OXIDANT INJECTION OBSERVATION

| Job Steps | Personal Protective Equipment | Potential Hazard | Critical Actions |
|---|---|---|---|
| Set up necessary traffic control. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves. | Struck by vehicle during placement.<br>Vehicle accident resulting from improper placement of traffic control equipment. | • Use buddy system to place traffic control. |
| Observe set up of oxidation system. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron, spray shield or hard hat spray shield, as required. | Struck by vehicle.<br>Trip hazards.<br>Accident when maneuvering equipment.<br>Delay or improper performance of work due to lack of necessary equipment on the Site. | • Have contractors locate oxidation system away from high-traffic areas.<br>• Store neatly, and protect with traffic control equipment (e.g., cones, barricades).<br>• Verify that subcontractors are aware of their responsibilities for labor, equipment, and supplies.<br>• Review permit conditions. |

| Job Steps | Personal Protective Equipment | Potential Hazard | Critical Actions |
|---|---|---|---|
| Set up exclusion zones(s) and work station. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves. | Struck by vehicle during setup.<br>Slip or fall hazards. | • Set up exclusion zones around well-head and oxidation system.<br>• Use safety tape and cones.<br>• Set up work station with clear walking paths to all injection locations.<br>• Face oncoming traffic. |
| Clear injection well point locations. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves. | Traffic hazards.<br>Product releases.<br>Property damage. | • Coordinate with Site Manager (or designee) to minimize potential conflicts.<br>• Select injection locations based on utility locates and desired injection coverage.<br>• Maintain at least 5 feet of clearance from movable objects.<br>• Develop traffic control plan, which may include use of cones, barrier tape, and/or jersey barriers, with client and local agencies, as applicable. |
| Observe liquid oxidant injection. | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or muffs, work gloves.<br>Full-face respirator or half-face respirator with organic vapor cartridges, with splash shield or goggles, HEPA filter cartridges, latex or nitrile gloves, coverall or Tyvek suit. | Oxidant splash hazard.<br>Unauthorized release of oxidant.<br>Exposure to oxidant (e.g., inhalation, dermal contact).<br>Pressure buildup in monitoring or remediation wells. | • Remove wells caps on existing monitoring or remediation wells in vicinity of injection area to prevent pressure buildup.<br>• Discuss injection contractor’s plan for injection.<br>• Keep work area tidy and free of loose equipment.<br>• Monitor oxidation injection from safe distance and collect data to ensure discharge is within permit parameters and capacity of storage containers (e.g., concentrations and flow rates). |

| Job Steps | Personal Protective Equipment | Potential Hazard | Critical Actions |
|---|---|---|---|
| Clean the Site; demobilize. | Steel-toed and -shank shoes, hard hat, safety glasses with side shields, hearing protection, reflective safety vest, leather gloves for non-chemical aspects of work. | Traffic.<br>Safety hazard left on the Site.<br>Lifting hazards. | • Use buddy system to remove traffic control, as necessary.<br>• Leave the Site clean of refuse and debris.<br>• Use proper lifting techniques.<br>• Monitor injection and well locations for discharges. If discharges occur, direct contractor to remediate.<br>• Notify Site personnel of final well locations, cuttings, and/or purge water left on the Site, and departure. |
| **General** | | | |
| Typical work. | Steel-toed and -shank shoes, hard hat, safety glasses with side shields, hearing protection, reflective safety vest, leather gloves for non-chemical aspects of work, chemical-resistant gloves, aprons, etc., if chemical exposure is suspected. | Weather-related incidents (e.g., automobile accidents, slips, falls). | • Check weather reports daily. Project visits are not to be performed during inclement weather. Sampling may be performed during light rain mist. Wear raincoat.<br>• Drive at speed limit, or less as needed to keep safe distance from vehicle in front. Avoid short stops. |

| Job Steps | Personal Protective Equipment | Potential Hazard | Critical Actions |
|---|---|---|---|
| Typical work. |  | Cold stress. | • For temperatures below 40°F, adequate insulating clothing must be worn. If temperature is below 20°F, workers are to be allowed to enter a heated shelter at regular intervals. Warm, sweet drinks should be available. Coffee intake should be limited.<br>• No one should begin work or return to work from heated shelter wearing wet clothes.<br>• Workers should be aware of signs of cold stress, such as heavy shivering, pain in fingers or toes, drowsiness, or irritability. Onset of any of these signs is indication for immediate return to heated shelter.<br>• Refer to ACGIH TLV Booklet for the section on Cold Stress. |
| Typical work. |  | Heat stress. | • Discuss health effects and symptoms during daily meetings.<br>• Drink water regularly—at least 1 cup every 20 to 30 minutes, depending upon level of effort and PPE worn.<br>• Refer to ACGIH TLV booklet for heat stress guidance, especially regarding PPE, type of work, and frequency of breaks. Breaks should be taken in an area cooler than work area.<br>• Monitor temperature and relative humidity using WBGT meter. |

## 9.4 CONTRACTOR OBSERVATION

| Job Steps | Personal Protective Equipment (PPE) | Potential Hazards | Critical Actions |
|---|---|---|---|
| Set up exclusion zone(s). | Reflective vest, steel-toed and -shank shoes, hard hat, safety glasses with side shields, ear plugs or ear muffs, work gloves. | Struck by vehicle.<br>Slip or fall hazards to workers. | • Face incoming traffic.<br>• Implement exclusion zone setup instructions of the HASP (e.g., barricades, caution tape, cones).<br>• Set up work area free of trip hazards. |
| Typical work. Observe and document contractor activities. | Steel-toe and -shank shoes, hard hat, safety glasses with side shields, hearing protection, reflective safety vest, leather gloves for non-chemical aspects of work.<br>Chemical-resistant gloves and apron if chemical exposure is suspected. | Weather-related incidents: automobile accidents, slips, or falls. | • Check weather reports daily. Project visits are not to be performed during inclement weather. Sampling may be performed during light rain mist. Wear raincoats.<br>• Drive at speed limit or less, as needed, to keep a safe distance from vehicle in front. Avoid short stops. |
| Typical work. Observation of work performed by contractor(s). | | Cold stress. | • For temperatures below 40 degrees Fahrenheit (°F), adequate insulating clothing must be worn. If the temperature is below 20°F, workers will be allowed to enter a heated shelter at regular intervals. Warm, sweet drinks should be available. Coffee intake should be limited.<br>• No one should begin work or return to work from a heated shelter with wet clothes. Workers should be aware of signs of cold stress such as heavy shivering, pain in fingers or toes, drowsiness, or irritability. Onset of these signs is an indication that immediate return to a heated shelter is needed.<br>• Refer to ACGIH TLV Booklet for section on Cold Stress. |

| Job Steps | Personal Protective Equipment (PPE) | Potential Hazards | Critical Actions |
|---|---|---|---|
| Clean the Site; demobilize. | Reflective vest, steel-toe and -shank shoes, hard hat, safety glasses with side shields, ear plugs or ear muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Traffic<br>Lifting hazards | • Use buddy system to remove traffic control.<br>• Leave Site clear of refuse and debris. Clearly mark or barricade any borings that need topping off or curing at a later time. Notify Site personnel of departure, final well locations, and any cuttings and/or purge water left on the Site.<br>• Use proper lifting techniques. |
| No eating, drinking, or smoking on the Site.<br>No contact lenses to be worn on the Site.<br>No facial hair that would interfere with respirator fit. | | | |
| A safety meeting will be held every day, even if only one person is working on the project on a given day. | | | • Topics are to always include the work scheduled for the day and restatement of hazards and the means to avoid them. Other topics may include sampling in general, and advances in technology and how they may be applied to the project. Use the *Daily Health and Safety Briefing Log* in **Attachment 4** to log the topics discussed. |

## 9.5 SSDS OPERATION AND MAINTENANCE

| Job Steps | Personal Protective Equipment | Potential Hazard | Critical Actions |
|---|---|---|---|
| Mobilize with proper equipment/supplies for operation and maintenance (O&M). | Safety glasses or goggles, hard hat, steel-toed and -shank boots, hearing protection, gloves. | Vehicle accident.<br>Lifting hazards.<br>Delay or improper performance of work due to improper equipment on Site. | • Follow safe driving procedures.<br>• Employ safe lifting procedures.<br>• Ensure subcontractors are aware of their responsibilities for labor, equipment, and supplies.<br>• Review HASP and permit conditions and gather necessary PPE. |
| Unload and set up test equipment. | Safety glasses or goggles, hard hat, steel-toed and -shank boots, hearing protection, gloves. | Struck by vehicle.<br>Trip hazards.<br>Accident when maneuvering equipment.<br>Lifting hazard.<br>Electrical hazard.<br>Adverse impacts to station sales. | • Place equipment away from pump islands or other high traffic areas.<br>• Store hoses and electrical cords neatly and protect with traffic control equipment (e.g., cones, barricades).<br>• Provide hand signals and guidance to driver, as needed, when placing testing equipment trailers or other large equipment.<br>• Visually inspect equipment (e.g., fire extinguisher on board/available on the Site, no damaged hoses or electrical lines, pressurized hoses secured with whip-checks or adequate substitute, vapor and/or water hoses firmly connected, equipment grounded).<br>• Use proper lifting techniques.<br>• Use ground fault circuit interrupter (GFCI) on generators or other electrical equipment.<br>• Inspect cords. |

| Job Steps | Personal Protective Equipment | Potential Hazard | Critical Actions |
|---|---|---|---|
| Commence performing O&M. | Safety glasses or goggles, hard hat, steel-toed and -shank boots, hearing protection, gloves. | Explosion or fire.<br>Trip hazards.<br>Unauthorized release of contaminants.<br>Eye injury from pressurized air or shrapnel from burst piping.<br>Burn from heated piping or motors.<br>Clothing caught on turning vanes on compressor and shaft.<br>Exposure to contaminants (e.g., inhalation, dermal contact).<br>Noise.<br>Electrical hazards. | • Follow equipment-specific operation instructions.<br>• Ensure that connections with barbed fittings on pressure gauges are secure.<br>• Be conscious of amount of torque on polyvinyl chloride connections to avoid breaking.<br>• Monitor pressure conditions; do not exceed pressure ratings for any component involved.<br>• Watch proximity to heated piping and contact with mufflers, motors, manifolds.<br>• Monitor influent vapor and oxygen concentrations, if applicable.<br>• Keep work area tidy and free of loose equipment.<br>• Monitor treatment system and collect data to ensure discharge is within permit parameters and capacity of storage containers (e.g., concentrations, flow rates).<br>• Wear PPE in accordance with HASP (including ear protection, as necessary).<br>• Ensure lockout/tagout of all electrical equipment that may be handled.<br>• Use GFCI.<br>• Inspect cords. |

| Job Steps | Personal Protective Equipment | Potential Hazard | Critical Actions |
|---|---|---|---|
| Shut down system (if necessary). | Safety glasses or goggles, hard hat, steel-toed and -shank boots, hearing protection, gloves. | Unauthorized release of contaminants from back pressure.<br>Eye injury from pressurized air or shrapnel from burst piping.<br>Burn from heated piping or motors.<br>Exposure to contaminants (e.g., inhalation, dermal contact). | |
| Collect samples in accordance with sampling plan. | Safety glasses or goggles, hard hat, steel-toed and -shank boots, hearing protection, gloves. | Cross-contamination, improper sample labeling or storage, exposure to Site contaminants.<br>Repetitive motion.<br>Cuts from colorimetric tubes.<br>Body position. | • Label samples in accordance with sampling plan. Keep samples stored in proper containers, at correct temperature, and away from work area.<br>• Perform air monitoring and wear proper PPE. |
| Clean the Site; demobilize. | Safety glasses or goggles, hard hat, steel-toed and -shank boots, hearing protection, gloves. | Traffic hazard.<br>Lifting hazards.<br>Safety hazard left on the Site. | • Use buddy system, as necessary, to remove traffic control.<br>• Use proper lifting techniques.<br>• Leave the Site clean of refuse and debris.<br>• Notify station personnel of departure and location of any stored waste. |

## 9.6 VAPOR INTRUSION MONITORING

| Job Steps | Personal Protective Equipment (PPE) | Potential Hazards | Critical Actions |
|---|---|---|---|
| Mobilize with equipment/supplies suitable for drilling. | Reflective vest, steel-toe and -shank shoes, hard hat, safety glasses with side shields, and work gloves. | Vehicle accident.<br>Lifting hazards.<br>Delay or improper performance of work due to improper equipment on the Site. | • Begin each work day with tailgate safety meeting.<br>• Follow safe driving procedures.<br>• Employ safe lifting procedures.<br>• Verify that subcontractors are aware of their responsibilities for labor, equipment, and supplies.<br>• Review permit conditions. |
| Unload and set up test equipment. | Safety glasses or goggles, hard hat, steel-toed and -shank boots, hearing protection, gloves. | Struck by vehicle.<br>Trip hazards.<br>Accident when maneuvering equipment.<br>Lifting hazard.<br>Electrical hazard.<br>Adverse impacts to station sales. | • Place equipment away from pump islands or other high traffic areas.<br>• Store hoses and electrical cords neatly and protect with traffic control equipment (e.g., cones, barricades).<br>• Provide hand signals and guidance to driver, as needed, when placing testing equipment trailers or other large equipment.<br>• Visually inspect equipment (e.g., fire extinguisher on board/available on the Site, no damaged hoses or electrical lines, pressurized hoses secured with whip-checks or adequate substitute, all vapor and/or water hoses firmly connected, equipment grounded).<br>• Use proper lifting techniques.<br>• Use GFCI on generators or other electrical equipment.<br>• Inspect cords. |

| Job Steps | Personal Protective Equipment (PPE) | Potential Hazards | Critical Actions |
|---|---|---|---|
| Collect samples in accordance with sampling plan. | Reflective vest, steel-toe and -shank shoes, hard hat, safety glasses with side shields, ear plugs or ear muffs, work gloves.<br>Respirator with organic vapor cartridges, chemical-resistant gloves, chemical-resistant apron as required. | Back strain.<br>Heat or cold.<br>Eye injury.<br>Noise.<br>Exposure to chemical hazards.<br>Breaching an underground utility.<br>Trip or fall.<br>Equipment failure. | • Stand clear of operating equipment.<br>• Use correct lifting techniques. Monitor air quality in accordance with the air monitoring protocol presented in Attachment 9. Monitor drilling progress.<br>• Keep work area clear of tripping or slipping hazards.<br>• Perform periodic visual inspections of drill rig. |
| Clean the Site; demobilize. | Safety glasses or goggles, hard hat, steel-toed and -shank boots, hearing protection, gloves. | Traffic hazard.<br>Lifting hazards.<br>Safety hazard left on the Site. | • Use buddy system, as necessary, to remove traffic control.<br>• Use proper lifting techniques.<br>• Leave the Site clean of refuse and debris.<br>• Notify station personnel of departure and location of any stored waste. |

# 10.0 WASTE CHARACTERISTICS

Waste anticipated to be generated on the Site:

Type(s): ☒ Liquid ☒ Solid ☐ Sludge ☐ Other ______________________

The approximate volume for each anticipated waste stream:

Waste: Decontamination/Purge Water Approximate Volume: One 55-gallon drum

Waste: Soil Cuttings Approximate Volume: Two to three 55-gallon drums

Characteristics:

☐ Corrosive ☐ Flammable/Ignitable ☐ Radioactive ☒ Toxic

☐ Reactive ☐ Unknown ☐ Other *(specify)*_____________________

# 11.0 TRAFFIC CONTROL

Work on the Site will be conducted in areas of uncontrolled traffic access. Traffic control/warning devices will be placed around the work area to prevent undesirable interface between pedestrian and automotive traffic and project workers and equipment. These devices may include:

- Cones;
- Tubular markers;
- Barricades;
- Temporary fencing; and
- Barricade tape.

The traffic control/warning devices will be placed around the work in such a way that traffic access is inhibited (i.e., place cones less than 8 feet apart so cars cannot easily drive through work area without moving a cone). Barricade tape or temporary fencing will be used to inhibit access to the work area in locations where pedestrians will be encountered.

# ATTACHMENT 1
# HEALTH AND SAFETY PLAN ACKNOWLEDGEMENT AND AGREEMENT FORM

HEALTH AND SAFETY PLAN
Remedial Investigation Monitoring, Vapor Mitigation
System Operations, and Chemical Injections
Capital Industries, Inc.
5801 Third Avenue South
Seattle, Washington

Farallon PN: 457-007 and 457-008

# HEALTH AND SAFETY PLAN ACKNOWLEDGMENT AND AGREEMENT FORM

***(All Farallon and subcontractor personnel must sign on a daily basis.)***

This Health and Safety Plan (HASP) has been developed for the purpose of informing Farallon employees of the hazards they are likely to encounter on the project site, and the precautions they should take to avoid those hazards. Subcontractors and other parties at the site must develop their own HASP to address the hazards faced by their own employees. Farallon will make a copy of this HASP available to subcontractors and other interested parties to fully disclose hazards we may be aware of, and to satisfy Farallon's responsibilities under the Occupational Safety and Health Administration (OSHA) Hazard Communication standard. Similarly, subcontractors and others on site are required to inform Farallon of any hazards they are aware of or that their work on site might possibly pose to Farallon employees, including but not limited to Material Safety Data Sheets for chemicals brought on site. This plan should NOT be understood by contractors to provide information pertaining to all of the hazards that a contractor's employees may be exposed to as a result of their work.

All parties conducting site activities are required to coordinate their activities and practices with the project Site Health and Safety Officer (SHSO). Your signature below affirms that you have read and understand the hazards discussed in this HASP, and that you understand that subcontractors and other parties working on site must develop their own HASP for their employees. Your signature also affirms that you understand that you could be prohibited by the SHSO or other Farallon personnel from working on this project for not complying with any aspect of this HASP. The SHSO will be noted on the sheet below on a daily basis.

**HEALTH AND SAFETY PLAN ACKNOWLEDGMENT AND AGREEMENT FORM**

| Check for SHSO | Name | Title | Signature | Company | Date |
|---|---|---|---|---|---|
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## HEALTH AND SAFETY PLAN ACKNOWLEDGMENT AND AGREEMENT FORM

| Check for SHSO | Name | Title | Signature | Company | Date |
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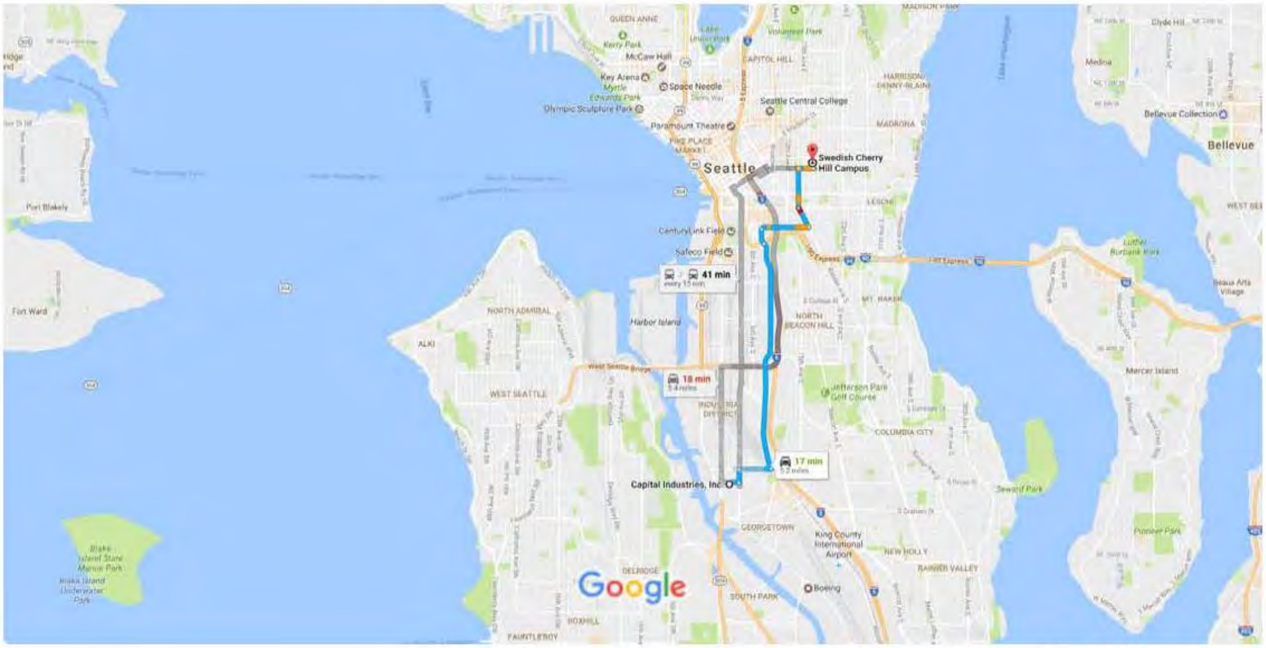
# ATTACHMENT 2
# DIRECTIONS TO HOSPITAL

HEALTH AND SAFETY PLAN
Remedial Investigation Monitoring, Vapor Mitigation
System Operations, and Chemical Injections
Capital Industries, Inc.
5801 Third Avenue South
Seattle, Washington

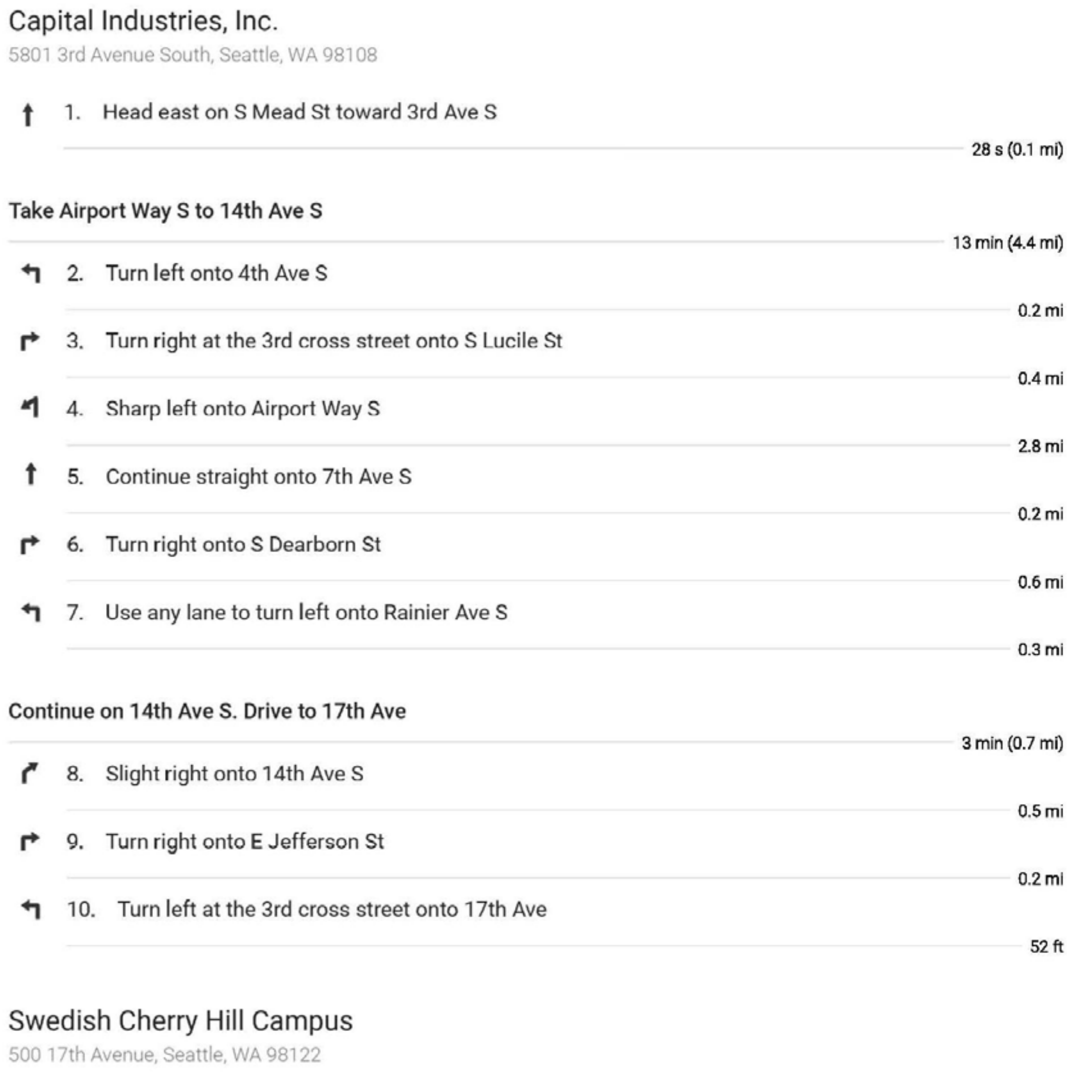
Farallon PN: 457-007 and 457-008

# DIRECTIONS TO HOSPITAL

Google Maps **Capital Industries, Inc. to Swedish Cherry Hill Campus** Drive 5.2 miles, 17 min



Map data ©2016 Google 2000 ft



Capital Industries, Inc.
5801 3rd Avenue South, Seattle, WA 98108

1. Head east on S Mead St toward 3rd Ave S

28 s (0.1 mi)

**Take Airport Way S to 14th Ave S**

13 min (4.4 mi)

2. Turn left onto 4th Ave S

0.2 mi

3. Turn right at the 3rd cross street onto S Lucile St

0.4 mi

4. Sharp left onto Airport Way S

2.8 mi

5. Continue straight onto 7th Ave S

0.2 mi

6. Turn right onto S Dearborn St

0.6 mi

7. Use any lane to turn left onto Rainier Ave S

0.3 mi

**Continue on 14th Ave S. Drive to 17th Ave**

3 min (0.7 mi)

8. Slight right onto 14th Ave S

0.5 mi

9. Turn right onto E Jefferson St

0.2 mi

10. Turn left at the 3rd cross street onto 17th Ave

52 ft

Swedish Cherry Hill Campus
500 17th Avenue, Seattle, WA 98122

# ATTACHMENT 3
# POTENTIAL TOPICS FOR DAILY HEALTH AND SAFETY MEETING

HEALTH AND SAFETY PLAN
Remedial Investigation Monitoring, Vapor Mitigation
System Operations, and Chemical Injections
Capital Industries, Inc.
5801 Third Avenue South
Seattle, Washington

Farallon PN: 457-007 and 457-008

# POTENTIAL TOPICS FOR DAILY HEALTH AND SAFETY MEETING

- ☐ Emergency response plan, emergency vehicle (full of fuel) and muster point
- ☐ Route to medical aid (hospital or other facility)
- ☐ Work hours. Is night work planned?
- ☐ Hand signals around heavy equipment
- ☐ Traffic control
- ☐ Pertinent legislation and regulations
- ☐ Above- and below-ground utilities (energized or de-energized)
- ☐ Material Safety Data Sheets
- ☐ Reporting an incident: to whom, what, why, and when to report
- ☐ Fire extinguisher and first aid kit locations
- ☐ Excavations, trenching, sloping, and shoring
- ☐ Personal protective equipment and training
- ☐ Safety equipment and training
- ☐ Emergency telephone location(s) and telephone numbers (in addition to 911)
- ☐ Eye wash stations and washroom locations
- ☐ Energy lock-out/tag-out procedures. Location of “kill switches,” etc.
- ☐ Weather restrictions
- ☐ Site security. Site hazards. Is special waste present?
- ☐ Traffic and people movement
- ☐ Working around machinery (both static and mobile)
- ☐ Sources of ignition, static electricity, etc.
- ☐ Stings, bites, large animals, and other nature-related injuries and conditions
- ☐ Working above grade
- ☐ Working at isolated sites
- ☐ Decontamination procedures (for both personnel and equipment)
- ☐ How to prevent falls, trips, sprains, and lifting injuries
- ☐ Right to refuse unsafe work
- ☐ Adjacent property issues (e.g., residence, business, school, daycare center)

# ATTACHMENT 4
# DAILY HEALTH AND SAFETY BRIEFING LOG

HEALTH AND SAFETY PLAN
Remedial Investigation Monitoring, Vapor Mitigation
System Operations, and Chemical Injections
Capital Industries, Inc.
5801 Third Avenue South
Seattle, Washington

Farallon PN: 457-007 and 457-008

# DAILY HEALTH AND SAFETY BRIEFING LOG

## PROJECT INFORMATION

| | |
|---|---|
| Farallon PN: | Project Name: |
| Site Address: | City/State: |

## MEETING INFORMATION

| | |
|---|---|
| Conducted By: | Weather: |
| Major Job Task: | Date: |

## DAILY EQUIPMENT CHECKLIST

☐ Site Check In
☐ Proper ID/Safety Credentials
☐ Hard Hat
☐ Safety Glasses
☐ Orange Reflective Vest (H or X back BNSF)
☐ Safety Toe Boots (lace up and leather BNSF)

☐ First Aid Kit Location(s)
☐ Fire Extinguisher Location(s)
☐ Eye Wash Station
☐ Traffic Control (if needed)

☐ Ear Plugs (if required)
☐ Hand Protection (if required)
☐ Face Shield (if required)
☐ Respirator (if required)
☐ ___________________________
☐ ___________________________

## HEALTH AND SAFETY BRIEFING

| | |
|---|---|
| ☐ Head Count (No. of employees: ) | ☐ Chemical/Contaminant Hazards |
| ☐ Emergency Response | ☐ Health Hazards |
| ☐ Who will...? (Provide names below.)<br>Call 911:<br>Alternate to call 911:<br>Provide First Aid/CPR: | ☐ Environmental Hazards<br>☐ Physical Hazards<br>☐ Slips, Trips, and Falls<br>☐ Utility Locates |
| ☐ Emergency Exits/Rally Points/Hospital Route | ☐ Utility/Product Shut-Off Valves/Switches |
| ☐ Site Security and Exclusion Zone | ☐ Near Miss Reporting (reminder to look) |
| ☐ Vehicle/Equipment-Specific Safety Practices | ☐ Incident Reporting (procedures and forms) |
| ☐ Stop Work Authority | ☐ Traffic Control |
| ☐ Excavation Safety (if applicable) | ☐ HASP Reviewed and Signed |

## OTHER SITE-SPECIFIC HEALTH AND SAFETY ISSUES DISCUSSED

1)
2)
3)
4)
5)

## DAILY HEALTH AND SAFETY BRIEFING ATTENDEES

| NAME | COMPANY | SIGNATURE |
|---|---|---|
| | | |
| | | |
| | | |
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# ATTACHMENT 5
# INCIDENT REPORT FORM

HEALTH AND SAFETY PLAN
Remedial Investigation Monitoring, Vapor Mitigation
System Operations, and Chemical Injections
Capital Industries, Inc.
5801 Third Avenue South
Seattle, Washington

Farallon PN: 457-007 and 457-008

# Accidental Injury, Occupational Illness, or Workplace Incident
## INCIDENT REPORT

## INCIDENT TYPE

**INCIDENT DATE:**

☐ FATALITY
☐ LOST WORKDAY
☐ LW RESTRICTED DUTY
☐ OSHA MEDICAL OR ILLNESS W/O LW
☐ FIRST AID

☐ INDUSTRIAL NON-RECORDABLE
☐ NON-INDUSTRIAL
☐ OFF-THE-JOB INJURY
☐ MVA
☐ FIRE

☐ SPILL/LEAK
☐ PRODUCT INTEGRITY
☐ EQUIPMENT
☐ BUSINESS INTERRUPTION

**(TO BE COMPLETED BY HEALTH AND SAFETY COORDINATOR)**

☐ GENERAL LIABILITY
☐ CRIMINAL ACTIVITY
☐ NOTICE OF VIOLATION
☐ OTHER

This report must be completed by the employee or Health and Safety Coordinator immediately upon learning of the incident. The completed report must be reviewed and signed by a Principal, within 24 hours of the incident, even if employee is not available to review and sign. Employee or employee's doctor must submit a copy of the doctor's report to Joe Rounds within 24 hours of the initial exam and any subsequent exams. After hours or weekends, please call Joe Rounds, Mobile (206) 484-2748.

## EMPLOYEE INFO

| | | | |
|---|---|---|---|
| LAST NAME: | FIRST NAME AND MIDDLE INITIAL: | TITLE: | TIME OF EVENT OR EXPOSURE:<br>☐ AM ☐ PM |

EMPLOYMENT STATUS: ☐ FULL-TIME ☐ PART-TIME ☐ HOURLY-AS-NEEDED

HOW LONG?

DATE OF INJURY OR ONSET OF ILLNESS (MM/DD/YYYY)

## INJURY OR ILLNESS INFO

EXACT LOCATION OF INCIDENT (ADDRESS, GEOGRAPHICAL LOCATION, FLOOR, BUILDING, ETC.):

COUNTY:

ON EMPLOYER'S PREMISES? ☐ YES ☐ NO

COMPLETE DESCRIPTION OF INCIDENT, INCLUDE SPECIFIC ACTIVITY DURING INCIDENT (LIFTING, PUSHING, WALKING, ETC.):

DESCRIBE THE EQUIPMENT, MATERIALS, OR CHEMICALS THAT DIRECTLY HARMED THE PARTY (E.G., THE MACHINE EMPLOYEE STRUCK AGAINST OR WHICH STRUCK EMPLOYEE; THE VAPOR INHALED OR MATERIAL SWALLOWED; WHAT THE EMPLOYEE WAS LIFTING, PULLING, ETC.):

DESCRIBE THE SPECIFIC INJURY OR ILLNESS (E.G., CUT, STRAIN, FRACTURE, SKIN RASH, ETC.):

BODY PART(S) AFFECTED (E.G., BACK, LEFT WRIST, RIGHT EYE, ETC.):

DATE EMPLOYER NOTIFIED:

TO WHOM REPORTED:

## MEDICAL PROVIDER (HOSPITAL, DOCTOR, CLINIC, ETC.) INFO

NAME AND ADDRESS OF HEALTH CARE PROVIDER:

PHONE NO.:

TREATED IN EMERGENCY ROOM: ☐ YES ☐ NO

HOSPITALIZED OVERNIGHT AS INPATIENT: ☐ YES ☐ NO

**ILLNESS/INJURY SEVERITY**

☐ NO TREATMENT REQUIRED
☐ FIRST AID ONLY
☐ MEDICAL TREATMENT
☐ FATALITY, ENTER DATE:

**TIME LOSS (Check all that apply)**

☐ RETURN TO WORK THE NEXT DAY
☐ NO TIME LOSS
☐ RESTRICTED ACTIVITY
  BEGIN DATE:
  RETURN DATE:
☐ LOST WORKDAY, NOT AT WORK
  BEGIN DATE:
  RETURN DATE:

**WORKDAY PHASE**

☐ PERFORM NORMAL WORK DUTIES
☐ MEAL PERIOD
☐ REST PERIOD
☐ ENTERING/LEAVING
☐ CHRONIC EXPOSURE
☐ OTHER, SPECIFY:

| | | | | | |
|---|---|---|---|---|---|
| **MOTOR VEHICLE ACCIDENT (MVA)** | | | PROFESSIONAL DRIVER? | ☐ YES ☐ NO | |
| TOTAL YEARS DRIVING: | COMPANY VEHICLE?<br>☐ YES ☐ NO | | VEHICLE TYPE: | | |
| NO. OF VEHICLES TOWED | NO. OF INJURIES: | | NO. OF FATALITIES: | | |
| **THIRD-PARTY INCIDENTS** | | | | | |
| NAME OF OWNER | | ADDRESS | | PHONE NO.: | |
| DESCRIPTION OF DAMAGE: | | | | | |
| INSURANCE INFORMATION: | | | | | |
| WITNESS NAME | | ADDRESS | | PHONE NO.: | |
| WITNESS NAME | | ADDRESS | | PHONE NO.: | |

**REVIEWED BY**

| NAME (PRINT) | SIGNATURE | TITLE | DATE |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

**ADDITIONAL INFORMATION** (USE SPACE BELOW FOR ADDITIONAL INFORMATION AS NECESSARY TO COMPLETE THIS FORM.)

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# ATTACHMENT 6
# SAFETY OBSERVATION AND NEAR MISS REPORT

HEALTH AND SAFETY PLAN
Remedial Investigation Monitoring, Vapor Mitigation
System Operations, and Chemical Injections
Capital Industries, Inc.
5801 Third Avenue South
Seattle, Washington

Farallon PN: 457-007 and 457-008

# SAFETY OBSERVATION AND NEAR MISS REPORT

This report is to be filled out by any employee involved in or witnessing a near miss, or making a safety observation. A near miss is an incident that did not result in any personal injury, property damage, or production interruption, but could have under slightly different circumstances. A safety observation is witnessing any activity that places a person or property at risk of injury, accident, or damage. These are very important indicators of potentially harmful future accidents, and provide valuable insights to preventing personal injury and/or property damage.

| | |
|---|---|
| **PROJECT INFORMATION** | |
| Farallon PN: | Project Name: |
| Site Address: | City/State: |
| **INCIDENT INFORMATION** | |
| Date: | Time: ☐ AM ☐ PM |
| Exact Location: | |
| Description of Incident or Potential Hazard: | |
| Corrective Action Taken: | |
| Lessons Learned: | |

Employee Signature ________________________________ Date: _____________________

Printed Name _____________________________________

Supervisor Signature _______________________________ Date: _____________________

Printed Name _____________________________________

# ATTACHMENT 7
# UTILITY CLEARANCE LOGS

HEALTH AND SAFETY PLAN
Remedial Investigation Monitoring, Vapor Mitigation
System Operations, and Chemical Injections
Capital Industries, Inc.
5801 Third Avenue South
Seattle, Washington

Farallon PN: 457-007 and 457-008

# UTILITY CLEARANCE LOG

**Project Name**: ________________________________ **Project Number:** ____________________

**Location**: ____________________________________ **Date of Work:** ______________________

**Instructions**. This log must be completed by a Farallon staff member **before** any Farallon-directed excavation (e.g., test pit excavation) or drilling operation.

**DRILLING OR EXCAVATION WORK MAY NOT COMMENCE**
**UNTIL UTILITY LOCATES HAVE BEEN COMPLETED**
**(see the One-Call Utility Locate Request Procedure on the following page)**

Farallon is responsible for having underground utilities and structures located and marked when drilling or directing test pit excavation operations. Any drilling or excavation within 2 feet of a marked utility must be done with hand tools.

Owners of underground utilities are required by law to mark underground facilities on public and private property. Owners of underground utilities are **not required** to mark existing service laterals or appurtenances. Utility owners in Washington are required to subscribe to the One-Call service.

Private utility locate services must be hired to locate service laterals and other buried utilities (e.g., on-Site electric distribution lines, irrigation pipes) on private property.

Re-mark after 10 days or maintain as appropriate.

## Utility Locate Checklist

☐ Attach map showing drilling and/or excavation sites and known utilities

☐ Attach copy of One-Call Utility Notification Ticket (http://www.searchandstatus.com/)

One-Call Utility Notification Ticket Number: ________________________________________

☐ Attach copy of Side Sewer Card (available for City of Seattle; check municipality for availability)

☐ Attach copy of Private Locate Receipt

☐ Photograph all excavation and/or drilling locations and download to project file

☐ Review utilities with Site Contact:

Name:________________________________ Phone: ___________________________________

## Utilities and Structures

| Utility Type | Utility Name | Public Utilities Marked (Y/N) | Private Utilities/Laterals Marked (Y/N) | Marking Method (flags, wooden stakes, paint on pavement, etc.) |
|---|---|---|---|---|
| Petroleum product lines | | | | |
| Natural gas line | | | | |
| Water line | | | | |
| Sewer line | | | | |
| Storm drain | | | | |
| Telephone cable | | | | |
| Electric power line | | | | |
| Product tank | | | | |
| Septic tank/drain field | | | | |
| Other | | | | |
| | | | | |

Farallon Consulting, L.L.C.

Field Team Leader: ___________________________________ Date: __________________________

| | | | | | |
|---|---|---|---|---|---|
| *Electric =*<br>**RED** | *Gas-Oil-Steam =*<br>**YELLOW** | *Comm-CATV =*<br>**ORANGE** | *Water =*<br>**BLUE/PURPLE** | *Sewer =*<br>**GREEN** | *Temp Survey =*<br>**PINK** |

# ONE-CALL UTILITY LOCATE REQUEST PROCEDURE

## THE ONE-CALL UTILITY NOTIFICATION CENTER REQUIRES 48 HOURS NOTICE TO MARK UTILITIES BEFORE YOU CAN DIG OR DRILL

Washington: 1-800-424-5555
Oregon: 1-800-332-2344

Washington state law states that "before commencing **any** excavation," the excavator or driller must provide notice to all owners of underground utilities by use of the One-Call locator service, and that the excavator or driller shall not dig or drill until all known utilities are marked. To fully comply with the law, you **must** take the following steps:

1. **Call before you dig or drill:** Notify the One-Call Utility Notification Center (OCUNC) a minimum of 48 hours (2 full business days) before digging or drilling. Provide the following **required** information:
    a. Your name and phone number, company name and mailing address, and Farallon Account Number 25999.
    b. The type of work being done.
    c. Who the work is being done for.
    d. The county and city where the work is being done.
    e. The address or street where the work is being done.
    f. Marking Instructions: "Generally locate entire site including rights-of-way and easements."

    Provide the following information <u>if applicable or requested</u>:
    a. The name and phone number of an alternate contact person.
    b. If the work is being done within 10 feet of any overhead power lines.
    c. The nearest cross street.
    d. The distance and direction of the work site from the intersection.
    e. Township, range, section, and quarter section of the work site.
2. **Record the utilities that will be notified:** OCUNC will tell you the utilities that are on or adjacent to the work site, based on their database. Record the name(s) of the utility on the reverse side of this form.
3. **After the 48-hour waiting period, confirm that the utility locations have been marked:** Before digging or drilling, walk the work site and confirm that the utility companies have marked the utility locations in the field.
4. **If a locate appears to be missing:** If a utility locate appears to be missing and the utility company has not notified you that there are no utilities in the area, call OCUNC and:
    **a. Provide the OCUNC locate number.**
    **b. Clearly state which utility has not been marked. The call is being recorded.**
    **c. Ask for a contact person at that utility.**

| *Electric =* | *Gas-Oil-Steam =* | *Comm-CATV =* | *Water =* | *Sewer =* | *Temp Survey =* |
|---|---|---|---|---|---|
| **RED** | **YELLOW** | **ORANGE** | **BLUE/PURPLE** | **GREEN** | **PINK** |

   d. **Call the contact person for the missing utility locate:** Determine why there is no utility locate in the field.
   e. **Record the reason(s) for the missing locate(s):** There are valid reasons that locates do not appear in the field (e.g., there are no utilities located on the work site or the utility has been abandoned). However, IF THEY ARE LATE, **YOU MUST WAIT** TO DRILL OR DIG. If the utility fails to mark a locate within the required 48 hours (2 full business days), the utility is liable for delay costs.

5. **Hand dig within 2 feet of a marked utility:** When digging or drilling within 2 feet of any marked utility, the utility must be exposed first by using hand tools.
6. **Record reason(s) for missing locate(s)**: There may be reasons that locates do not appear in the field (e.g., no utilities are located on the site, utility has been abandoned). Record the reason given. IF THEY ARE LATE – YOU WAIT TO DRILL OR DIG. If the utility failed to mark within the required two days, they are liable for delay costs.

| *Electric =* | *Gas-Oil-Steam =* | *Comm-CATV =* | *Water =* | *Sewer =* | *Temp Survey =* |
|---|---|---|---|---|---|
| **RED** | **YELLOW** | **ORANGE** | **BLUE/PURPLE** | **GREEN** | **PINK** |

**FARALLON CONSULTING, L.L.C.**
975 5th Avenue Northwest
Issaquah, Washington
98027

**TELEPHONE CONVERSATION**
**Date:** ____________________ **Time:** _________
**Project Name:** ____________________________
**Job No.:** _________________________________
**Phone No.: 1-800-424-5555 WA, 1-800-332-2344 OR**
_________________________________________
**Prepared By/Initials:** ______________________
**Call:** ☐ **Placed** ☐ **Received**

**Contact/Title:** ____________________________________________________________

**Agency/Region: One-Call Utility Notification Center**

**PROJECT:** ____________________________________________________________
**1. Your name and the Farallon Account No. #25999:** ______________________________
**2. What is the type of work being conducted (e.g., environmental drilling, test pit excavation)?**
________________________________________________________________________
**3. Who is the property owner?** ______________________________________________
**4. County and city were work is being done?** _________________________________
**5. Address or street where work is taking place?** _____________________________
________________________________________________________________________
6. Nearest cross street? ________________________________________________
7. Distance and direction of the work site from the intersection? ____________________
**8. Marking Instructions (generally locate on entire Site, including rights-of-way and easements):** ______________________________________________________
________________________________________________________________________
________________________________________________________________________
9. What time and date will the locate be completed? ______________________________
10. Utility Locate Request Number? __________________________________________
11. Utilities that will be notified? __________________________________________
________________________________________________________________________
12. Any Overhead Concerns? _________________________________________________
________________________________________________________________________
________________________________________________________________________
**cc:**_______________________________________**Page**____________**of**__________

**Note: Bold indicates required information.**

# ATTACHMENT 8
# FARALLON FIELD PERSONNEL TRAINING DATES

HEALTH AND SAFETY PLAN
Remedial Investigation Monitoring, Vapor Mitigation
System Operations, and Chemical Injections
Capital Industries, Inc.
5801 Third Avenue South
Seattle, Washington

Farallon PN: 457-007 and 457-008

# ATTACHMENT 9
# AIR MONITORING TABLE AND FORMS

HEALTH AND SAFETY PLAN
Remedial Investigation Monitoring, Vapor Mitigation
System Operations, and Chemical Injections
Capital Industries, Inc.
5801 Third Avenue South
Seattle, Washington

Farallon PN: 457-007 and 457-008

# ACTION LEVEL TABLE FOR AIR MONITORING

The Air Monitoring table (following page) presents protocol for monitoring ambient air for constituents of concern and other parameters that may affect worker safety. Please note the following with respect to use of this table:

- The Level for Respirator Use indicates the concentration at which a respirator must be donned. It does not require that the job stop. The respirator is a piece of equipment that is to be used while determining why a concentration has reached that level. Implement engineering controls such as water mist, spray foam, plastic cover, etc. to reduce the concentration.
- The Level for Work Stoppage indicates the concentration at which work on the job must stop. Determine why a concentration has reached that level, and how it can be decreased. Site evacuation is not necessary at this level. Stopping work does not imply that the concentration level will decrease. Implement engineering controls to reduce the concentration; resume work when it is safe to do so.
- These values can be modified under particular Site conditions and with specific knowledge of the contaminant(s). Should such conditions arise, contact Farallon's Health and Safety Officer at (425) 295-0800.

# AIR MONITORING

| Chemical (or Class) | Monitoring Equipment | Task | Monitoring Frequency and Location | Level for Respirator Use | Level for Work Stoppage |
|---|---|---|---|---|---|
| Volatile Organic Vapors | Flame ionization detector (FID)/photoionization detector (PID) as appropriate for chemicals of concern. Read manual to determine.<br>Draeger Tube for vinyl chloride (Model 1/a; Part Number 67 28031).<br>Draeger Tube for benzene (Model 0.5/a). | From start of mobilization to completion and demobilization. | Sampling should be continuous during the project while disturbing potentially contaminated soil, uncovering and/or removing tanks and piping, or drilling —at least every 15 minutes in the breathing zone.<br>Sample at the exclusion zone boundaries every 30 minutes. Continuously sample during each soil and groundwater sampling interval. If 10 parts per million (ppm) in breathing zone, collect a Draeger Tube for benzene and/or vinyl chloride (depending upon contaminants of concern). | 20 ppm above background sustained in breathing zone for 2 minutes, and no benzene and/or vinyl chloride tube discoloration. If a color change appears on the tube for benzene or vinyl chloride at 10 ppm on FID/PID, don respirator.<br>If no Draeger Tube is available, the level for respirator use is to be 5 ppm. | 50 ppm above background in breathing zone and no vinyl chloride or benzene tube discoloration. Stop work if tube indicates > 1 ppm for benzene or vinyl chloride.<br>If no Draeger Tube is available, stop work at 25 ppm. |

| Chemical (or Class) | Monitoring Equipment | Task | Monitoring Frequency and Location | Level for Respirator Use | Level for Work Stoppage |
|---|---|---|---|---|---|
| Metals (Dust and Particulates) | XRF Spectrometer as appropriate for metals of concerns. Read manual to determine.<br>Laboratory analysis for specific metals known to potentially be at levels exceeding respiratory protection requirements. | From start of mobilization to completion and demobilization. | Sampling should be continuous during the project while disturbing potentially contaminated soil at least every 15 minutes in the breathing zone.<br>Sample at the exclusion zone boundaries every 30 minutes. Continuously during each sampling interval or excavation lift (as possible). | 1 mg/m3 for mercury.<br>Any detectable concentration of cadmium less than the PEL of 0.005 mg/m3.<br>0.5 mg/m3 for lead. | 2.5 mg/m3 for mercury.<br>Any concentration exceeding 0.005 mg/m3 for cadmium.<br>50 mg/m3 for lead. |

# AIR MONITORING EQUIPMENT CALIBRATION/CHECK LOG

| Date | Instrument/ Model No. | Serial No. | Battery Check OK? | Zero Adjust OK? | Calibration Gas (ppm) | Reading (ppm) | Leak Check | Performed By | Comments |
|---|---|---|---|---|---|---|---|---|---|
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# AIR MONITORING LOG

| Date | Time | Location | Source/Area/ Breathing Zone | Instrument | Concentration/Units | Sampled by |
|---|---|---|---|---|---|---|
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# ATTACHMENT 10
# POTASSIUM PERMANGANATE SAFETY DATA SHEET

HEALTH AND SAFETY PLAN
Remedial Investigation Monitoring, Vapor Mitigation
System Operations, and Chemical Injections
Capital Industries, Inc.
5801 Third Avenue South
Seattle, Washington

Farallon PN: 457-007 and 457-008

# SAFETY DATA SHEET

## 1. Identification

| | |
|---|---|
| **Product identifier** | **Potassium Permanganate** |
| **Other means of identification** | Not available. |
| **Recommended use** | Potassium Permanganate is an oxidant recommended for applications that require a strong oxidant. |
| **Recommended restrictions** | Use in accordance with supplier's recommendations. |

**Manufacturer / Importer / Supplier / Distributor information**

| | |
|---|---|
| **Company name** | CARUS CORPORATION |
| **Address** | 315 Fifth Street,<br>Peru, IL 61354, USA |
| **Telephone** | 815 223-1500 - All other non-emergency inquiries about the product should be directed to the company |
| **E-mail** | salesmkt@caruscorporation.com |
| **Website** | www.caruscorporation.com |
| **Contact person** | Dr. Chithambarathanu Pillai |
| **Emergency Telephone** | For Hazardous Materials [or Dangerous Goods] Incidents ONLY<br>(spill, leak, fire, exposure or accident), call CHEMTREC at<br>CHEMTREC®, USA: 001 (800) 424-9300<br>CHEMTREC®, Mexico (Toll-Free - must be dialed from within country): 01-800-681-9531<br>CHEMTREC®, Other countries: 001 (703) 527-3887 |

## 2. Hazard(s) identification

| | | |
|---|---|---|
| **Physical hazards** | Oxidizing solids | Category 2 |
| **Health hazards** | Acute toxicity, oral | Category 4 |
| | Skin corrosion/irritation | Category 1B |
| | Specific target organ toxicity, single exposure | Category 1 (Respiratory System) |
| | Specific target organ toxicity, repeated exposure | Category 1 (Respiratory System, Central Nervous System) |
| **Environmental hazards** | Hazardous to the aquatic environment, acute hazard | Category 1 |
| | Hazardous to the aquatic environment, long-term hazard | Category 1 |
| **OSHA defined hazards** | Not classified. | |

**Label elements**

| | |
|---|---|
| **Signal word** | Danger |
| **Hazard statement** | May intensify fire; oxidizer. Harmful if swallowed. Causes severe skin burns and eye damage. Causes damage to organs (Respiratory System). Causes damage to organs (Respiratory System, Central Nervous System) through prolonged or repeated exposure. Very toxic to aquatic life. Very toxic to aquatic life with long lasting effects. |

**Precautionary statement**

| | |
|---|---|
| **Prevention** | Keep away from heat. Keep/Store away from clothing//combustible materials. Wash thoroughly after handling. Do not breathe dust. Wear protective gloves/protective clothing/eye protection/face protection. Do not eat, drink or smoke when using this product. Take any precaution to avoid mixing with combustibles. Avoid release to the environment. |
| **Response** | In case of fire: Use water for extinction. If swallowed: Rinse mouth. Do NOT induce vomiting. If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower. Wash contaminated clothing before reuse. If inhaled: Remove person to fresh air and keep comfortable for breathing. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Collect spillage. Immediately call a poison center/doctor. |
| **Storage** | Store locked up. |

| | |
|---|---|
| **Disposal** | Dispose of contents/container in accordance with local/regional/national/international regulations. |
| **Hazard(s) not otherwise classified (HNOC)** | None known. |

## 3. Composition/information on ingredients

**Substances**

| Chemical name | Common name and synonyms | CAS number | % |
|---|---|---|---|
| Potassium permanganate | | 7722-64-7 | >97.5 |

| | |
|---|---|
| **Composition comments** | All concentrations are in percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume. |

## 4. First-aid measures

| | |
|---|---|
| **Inhalation** | Remove victim to fresh air and keep at rest in a position comfortable for breathing. For breathing difficulties, oxygen may be necessary. Get medical attention immediately. |
| **Skin contact** | Remove contaminated clothing and shoes. Immediately flush skin with plenty of water. Get medical attention immediately. Wash contaminated clothing before reuse.<br>Contact with skin may leave a brown stain of insoluble manganese dioxide. This can be easily removed by washing with a mixture of equal volume of household vinegar and 3% hydrogen peroxide, followed by washing with soap and water. |
| **Eye contact** | Immediately flush with plenty of water for up to 15 minutes. Remove any contact lenses and open eyelids wide apart. Continue rinsing. Get medical attention immediately. |
| **Ingestion** | Immediately rinse mouth and drink plenty of water. Never give anything by mouth to a victim who is unconscious or is having convulsions. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Get medical attention immediately. |
| **Most important symptoms/effects, acute and delayed** | Contact with this material will cause burns to the skin, eyes and mucous membranes. Permanent eye damage including blindness could result. |
| **Indication of immediate medical attention and special treatment needed** | Provide general supportive measures and treat symptomatically. Decomposition products are alkaline. Brown stain is insoluble manganese dioxide. |
| **General information** | In the case of accident or if you feel unwell, seek medical advice immediately (show the label where possible). Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. |

## 5. Fire-fighting measures

| | |
|---|---|
| **Suitable extinguishing media** | Flood with water from a distance, water spray or fog. |
| **Unsuitable extinguishing media** | The following extinguishing media are ineffective: Dry chemical. Foam. Carbon dioxide (CO2). Halogenated materials. |
| **Specific hazards arising from the chemical** | May intensify fire; oxidizer. May ignite combustibles (wood, paper, oil, clothing, etc.). Contact with incompatible materials or heat (135 ºC / 275 ºF) could result in violent exothermic chemical reaction. Oxidizing agent, may cause spontaneous ignition of combustible materials. By heating and fire, corrosive vapors/gases may be formed. |
| **Special protective equipment and precautions for firefighters** | Self-contained breathing apparatus and full protective clothing must be worn in case of fire. Selection of respiratory protection for firefighting: follow the general fire precautions indicated in the workplace. |
| **Fire-fighting equipment/instructions** | Move container from fire area if it can be done without risk. Cool containers exposed to flames with water until well after the fire is out. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply. Dike fire control water for later disposal. Water runoff can cause environmental damage. |
| **General fire hazards** | The product is not flammable. May intensify fire; oxidizer. May ignite combustibles (wood, paper, oil, clothing, etc.). Contact with incompatible materials or heat (135 °C / 275 °F) could result in violent exothermic chemical reaction. |

## 6. Accidental release measures

| | |
|---|---|
| **Personal precautions, protective equipment and emergency procedures** | Keep unnecessary personnel away. Minimize dust generation and accumulation. Avoid inhalation of dust and contact with skin and eyes. Keep upwind. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Wear protective clothing as described in Section 8 of this safety data sheet. Local authorities should be advised if significant spillages cannot be contained. |

| | |
|---|---|
| **Methods and materials for containment and cleaning up** | Keep combustibles (wood, paper, oil, etc.) away from spilled material. Should not be released into the environment. This product is miscible in water. Stop leak if possible without any risk. Dike the spilled material, where this is possible. Clean up spills immediately by sweeping or shoveling up the material. Do not return spilled material to the original container; transfer to a clean metal or plastic drum. To clean up potassium permanganate solutions, follow either of the following two options:<br>Option # 1: Dilute to approximately 6% with water, and then reduce with sodium thiosulfate, a bisulfite or ferrous salt solution. The bisulfite or ferrous salt may require some dilute sulfuric acid (10% w/w) to promote reduction. Neutralize with sodium carbonate to neutral pH, if acid was used. Decant or filter and deposit sludge in approved landfill. Where permitted, the sludge may be drained into sewer with large quantities of water.<br>Option # 2: Absorb with inert media like diatomaceous earth or inert floor dry, collect into a drum and dispose of properly. Do not use saw dust or other incompatible media. Disposal of all materials shall be in full and strict compliance with all federal, state, and local regulations pertaining to permanganates.<br>To clean contaminated floors, flush with abundant quantities of water into sewer, if permitted by federal, state, and local regulations. If not, collect water and treat as described above.<br>Never return spills in original containers for re-use. |
| **Environmental precautions** | Do not allow to enter drains, sewers or watercourses. Contact local authorities in case of spillage to drain/aquatic environment. |

## 7. Handling and storage

| | |
|---|---|
| **Precautions for safe handling** | Take any precaution to avoid mixing with combustibles. Keep away from clothing and other combustible materials. Do not get this material in your eyes, on your skin, or on your clothing. Do not breathe dust or mist or vapor of the solution. If clothing becomes contaminated, remove and wash off immediately. When using, do not eat, drink or smoke. Good personal hygiene is necessary. Wash hands and contaminated areas with water and soap before leaving the work site. Avoid release to the environment. |
| **Conditions for safe storage, including any incompatibilities** | Store locked up. Keep container tightly closed and in a well-ventilated place. Store in a cool, dry place. Store away from incompatible materials (See Section 10). Follow applicable local/national/international recommendations on storage of oxidizers. Store in accordance with NFPA 430 requirements for Class II oxidizers. |

## 8. Exposure controls/personal protection

**Occupational exposure limits** No exposure limits noted for ingredient(s).

**US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)**

| Components | Type | Value |
|---|---|---|
| Potassium permanganate (CAS 7722-64-7) | Ceiling | 5 mg/m3 |

**US. ACGIH Threshold Limit Values**

| Components | Type | Value | Form |
|---|---|---|---|
| Potassium permanganate (CAS 7722-64-7) | TWA | 0.1 mg/m3 | Inhalable fraction. |
| | | 0.02 mg/m3 | Respirable fraction. |

**US. NIOSH: Pocket Guide to Chemical Hazards**

| Components | Type | Value | Form |
|---|---|---|---|
| Potassium permanganate (CAS 7722-64-7) | STEL | 3 mg/m3 | Fume. |
| | TWA | 1 mg/m3 | Fume. |

| | |
|---|---|
| **Biological limit values** | No biological exposure limits noted for the ingredient(s). |
| **Exposure guidelines** | Follow standard monitoring procedures. |
| **Appropriate engineering controls** | Provide adequate general and local exhaust ventilation. An eye wash and safety shower must be available in the immediate work area. |

**Individual protection measures, such as personal protective equipment**

| | |
|---|---|
| **Eye/face protection** | Wear safety glasses with side shields (or goggles). Wear face shield if there is risk of splashes. |
| **Skin protection** | |
| **Hand protection** | Use protective gloves made of: Rubber or plastic. Suitable gloves can be recommended by the glove supplier. |
| **Other** | Wear chemical-resistant, impervious gloves. |

**Respiratory protection**

In case of inadequate ventilation or risk of inhalation of dust, use suitable respiratory equipment with particle filter. In the United States of America, if respirators are used, a program should be instituted to assure compliance with OSHA 29 CFR 1910.134.

Measurement Element: Manganese (Mn)
10 mg/m3
Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100 or P100.
Any supplied-air respirator.

25 mg/m3
Any supplied-air respirator operated in a continuous-flow mode.
Any powered, air-purifying respirator with a high-efficiency particulate filter.

50 mg/m3
Any air-purifying, full-face piece respirator equipped with an N100, R100, or P100 filter.
Any supplied-air respirator with a tight-fitting face piece that is operated in a continuous-flow mode.
Any powered, air-purifying respirator with a tight-fitting face piece and a high-efficiency particulate filter.
Any self-contained breathing apparatus with a full face piece.
Any supplied-air respirator with a full face piece.

500 mg/m3
Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode.

Emergency or planned entry into unknown concentrations or IDLH conditions -
Any self-contained breathing apparatus that has a full face piece and is operated in a pressure-demand or other positive-pressure mode.

Escape
Any air-purifying, full-face piece respirator equipped with an N100, R100, or P100 filter.
Any appropriate escape-type, self-contained breathing apparatus.

**Thermal hazards** Wear appropriate thermal protective clothing, when necessary.

**General hygiene considerations** When using, do not eat, drink or smoke. Keep from contact with clothing and other combustible materials. Remove and wash contaminated clothing promptly. Wash hands before breaks and immediately after handling the product. Handle in accordance with good industrial hygiene and safety practice.

## 9. Physical and chemical properties

| | |
|---|---|
| **Appearance** | Not available. |
| **Physical state** | Solid. |
| **Form** | Powder. |
| **Color** | Dark purple. |
| **Odor** | Odorless. |
| **Odor threshold** | Not applicable. |
| **pH** | Not applicable. |
| **Melting point/freezing point** | Starts to decompose with evolution of oxygen (O2) at temperatures above 150 °C. Once initiated, the decomposition is exothermic and self sustaining. |
| **Initial boiling point and boiling range** | Not applicable. |
| **Flash point** | Not applicable. |
| **Evaporation rate** | Not applicable. |
| **Flammability (solid, gas)** | Non flammable. |
| **Upper/lower flammability or explosive limits** | |
| **Flammability limit - lower (%)** | Not applicable. |
| **Flammability limit - upper (%)** | Not applicable. |
| **Explosive limit - lower (%)** | Not available. |
| **Explosive limit - upper (%)** | Not available. |
| **Vapor pressure** | Not applicable. |
| **Vapor density** | Not applicable. |
| **Relative density** | 2.7 (20 °C) ( Water = 1) |

| | |
|---|---|
| **Solubility(ies)** | |
| **Solubility (water)** | 64 g/l water (20 °C) |
| **Partition coefficient (n-octanol/water)** | Not applicable. |
| **Auto-ignition temperature** | Not available. |
| **Decomposition temperature** | 464 °F (240 °C) |
| **Viscosity** | Not applicable. |
| **Other information** | |
| **Explosive properties** | Not explosive. Can explode in contact with sulfuric acid, peroxides and metal powders. |
| **Granulometry** | Mass median : 175.8 µm Particle size: D90 < 298 µm, D10 < 106.1 µm |
| **Molecular formula** | H-Mn-O4.K |
| **Molecular weight** | 158.03 g/mol |
| **Oxidizing properties** | Strong oxidizing agent. |

## 10. Stability and reactivity

| | |
|---|---|
| **Reactivity** | The product is stable and non-reactive under normal conditions of use, storage and transport. |
| **Chemical stability** | Stable at normal conditions. |
| **Possibility of hazardous reactions** | Contact with combustible material may cause fire. Can explode in contact with sulfuric acid, peroxides and metal powders. Starts to decompose with evolution of oxygen (O2) at temperatures above 150 °C. Once initiated, the decomposition is exothermic and self sustaining. |
| **Conditions to avoid** | Contact with incompatible materials or heat (135 °C / 275 °F) could result in violent exothermic chemical reaction. |
| **Incompatible materials** | Acids. Peroxides. Reducing agents. Combustible material. Metal powders. Contact with hydrochloric acid liberates chlorine gas. |
| **Hazardous decomposition products** | By heating and fire, corrosive vapors/gases may be formed. |

## 11. Toxicological information

| | |
|---|---|
| **Information on likely routes of exposure** | |
| **Ingestion** | Harmful if swallowed. |
| **Inhalation** | May cause irritation to the respiratory system. |
| **Skin contact** | Causes severe skin burns. |
| **Eye contact** | Causes serious eye damage. |
| **Symptoms related to the physical, chemical and toxicological characteristics** | Contact with this material will cause burns to the skin, eyes and mucous membranes. Permanent eye damage including blindness could result. |
| **Information on toxicological effects** | |
| **Acute toxicity** | Harmful if swallowed. |

| **Components** | **Species** | **Test Results** |
|---|---|---|
| Potassium permanganate (CAS 7722-64-7) | | |
| **Acute** | | |
| *Dermal* | | |
| LD50 | Rat | 2000 mg/kg |
| *Oral* | | |
| LD50 | Rat | 2000 mg/kg |

| | |
|---|---|
| **Skin corrosion/irritation** | Causes severe skin burns. |
| **Serious eye damage/eye irritation** | Causes serious eye damage. |
| **Respiratory or skin sensitization** | |
| **Respiratory sensitization** | Test data conclusive but not sufficient for classification. |
| **Skin sensitization** | Test data conclusive but not sufficient for classification. |
| **Germ cell mutagenicity** | Test data conclusive but not sufficient for classification. |
| **Carcinogenicity** | Test data conclusive but not sufficient for classification. |
| **Reproductive toxicity** | Test data conclusive but not sufficient for classification. |
| **Specific target organ toxicity - single exposure** | Causes damage to organs (respiratory system). |

**Specific target organ toxicity - repeated exposure** Causes damage to organs (respiratory system, central nervous system) through prolonged or repeated exposure.

**Aspiration hazard** Based on available data, the classification criteria are not met.

**Chronic effects** May cause damage to respiratory system. Prolonged exposure, usually over many years, to manganese oxide fume/dust can lead to chronic manganese poisoning, chiefly affecting the central nervous system.

**Further information** No other specific acute or chronic health impact noted.

## 12. Ecological information

**Ecotoxicity** Very toxic to aquatic life with long lasting effects.

| Components | | Species | Test Results |
|---|---|---|---|
| Potassium permanganate (CAS 7722-64-7) | | | |
| **Aquatic** | | | |
| Fish | LC50 | Bluegill (Lepomis macrochirus) | 2.7 mg/l, 96 hours, static |
| | | | 2.3 mg/l, 96 hours, flow through |
| | | | 2.3 mg/l, 96 hours |
| | | | 1.8 - 5.6 mg/l |
| | | Carp (Cyprinus carpio) | 3.16 - 3.77 mg/l, 96 hours |
| | | | 2.97 - 3.11 mg/l, 96 hours |
| | | Goldfish (Carassius auratus) | 3.3 - 3.93 mg/l, 96 hours, static |
| | | Milkfish, salmon-herring (Chanos chanos) | > 1.4 mg/l, 96 hours |
| | | Rainbow trout (Oncorhynchus mykiss) | 1.8 mg/l, 96 hours |
| | | | 1.08 - 1.38 mg/l, 96 hours |
| | | | 0.77 - 1.27 mg/l, 96 hours |
| | | Rainbow trout,donaldson trout (Oncorhynchus mykiss) | 0.275 - 0.339 mg/l, 96 hours |

**Persistence and degradability** Expected to be readily converted by oxidizable materials to insoluble manganese oxide.

**Bioaccumulative potential** Potential to bioaccumulate is low.

**Mobility in soil** Not available.

**Mobility in general** The product is water soluble and may spread in water systems.

**Other adverse effects** None known.

## 13. Disposal considerations

**Disposal instructions** Dispose of contents/container in accordance with local/regional/national/international regulations.

**Local disposal regulations** Dispose in accordance with all applicable regulations.

**Hazardous waste code** D001: Ignitable waste
The Waste code should be assigned in discussion between the user, the producer and the waste disposal company.

**Waste from residues / unused products** Do not allow this material to drain into sewers/water supplies. Dispose in accordance with all applicable regulations.

**Contaminated packaging** Since emptied containers may retain product residue, follow label warnings even after container is emptied. Rinse container at least three times to an absence of pink color before disposing. Empty containers should be taken to an approved waste handling site for recycling or disposal.

## 14. Transport information

**DOT**

**UN number** UN1490
**UN proper shipping name** Potassium permanganate
**Transport hazard class(es)**
**Class** 5.1
**Subsidiary risk** -
**Packing group** II
**Environmental hazards**
**Marine pollutant** Yes
**Special precautions for user** Not available.
**Special provisions** IB8, IP2, IP4, T3, TP33
**Packaging exceptions** 152
**Packaging non bulk** 212

| | |
|---|---|
| **Packaging bulk** | 240 |
| **IATA** | |
| **UN number** | UN1490 |
| **UN proper shipping name** | Potassium permanganate |
| **Transport hazard class(es)** | |
| **Class** | 5.1 |
| **Subsidiary risk** | - |
| **Label(s)** | 5.1 |
| **Packing group** | II |
| **Environmental hazards** | Yes |
| **ERG Code** | 5L |
| **Special precautions for user** | Read safety instructions, SDS and emergency procedures before handling. |
| **IMDG** | |
| **UN number** | UN1490 |
| **UN proper shipping name** | POTASSIUM PERMANGANATE |
| **Transport hazard class(es)** | |
| **Class** | 5.1 |
| **Subsidiary risk** | - |
| **Label(s)** | 5.1 |
| **Packing group** | II |
| **Environmental hazards** | |
| **Marine pollutant** | Yes |
| **EmS** | F-H, S-Q |
| **Special precautions for user** | Read safety instructions, SDS and emergency procedures before handling. |
| **Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code** | Not available. |

## 15. Regulatory information

**US federal regulations**

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
All components are on the U.S. EPA TSCA Inventory List.

CERCLA/SARA Hazardous Substances - Not applicable.

Drug Enforcement Administration (DEA) (21 CFR 1310.02 (b) 8: List II chemical.

Department of Homeland Security (DHS) Chemical Facility Anti-Terrorism Standards (6 CFR 27, Appendix A): Listed.

**TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)**

Not regulated.

**US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)**

Not listed.

**CERCLA Hazardous Substance List (40 CFR 302.4)**

| | |
|---|---|
| Potassium permanganate (CAS 7722-64-7) | LISTED |

**Superfund Amendments and Reauthorization Act of 1986 (SARA)**

**Hazard categories**

Immediate Hazard - No
Delayed Hazard - No
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - No

**SARA 302 Extremely hazardous substance**

Not listed.

**SARA 311/312 Hazardous chemical** Yes

**SARA 313 (TRI reporting)**

| Chemical name | CAS number | % by wt. |
|---|---|---|
| Potassium permanganate | 7722-64-7 | >97.5 |

**Other federal regulations**

**Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List**

Potassium permanganate (CAS 7722-64-7)

**Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)**

Not regulated.

**Safe Drinking Water Act (SDWA)** Not regulated.

**Drug Enforcement Administration (DEA). List 2, Essential Chemicals (21 CFR 1310.02(b) and 1310.04(f)(2) and Chemical Code Number**

| | |
|---|---|
| Potassium permanganate (CAS 7722-64-7) | 6579 |

**Drug Enforcement Administration (DEA). List 1 & 2 Exempt Chemical Mixtures (21 CFR 1310.12(c))**

| | |
|---|---|
| Potassium permanganate (CAS 7722-64-7) | 15 % wt |

**DEA Exempt Chemical Mixtures Code Number**

| | |
|---|---|
| Potassium permanganate (CAS 7722-64-7) | 6579 |

**US state regulations** This product does not contain a chemical known to the State of California to cause cancer, birth defects or other reproductive harm.

California OSH Hazardous Substance List: Listed.

**US. Massachusetts RTK - Substance List**

Potassium permanganate (CAS 7722-64-7)

**US. New Jersey Worker and Community Right-to-Know Act**

Potassium permanganate (CAS 7722-64-7)

**US. Pennsylvania Worker and Community Right-to-Know Law**

Potassium permanganate (CAS 7722-64-7)

**US. Rhode Island RTK**

Potassium permanganate (CAS 7722-64-7)

**US. California Proposition 65**

**US - California Proposition 65 - Carcinogens & Reproductive Toxicity (CRT): Listed substance**

Not listed.

**International Inventories**

| Country(s) or region | Inventory name | On inventory (yes/no)* |
|---|---|---|
| Australia | Australian Inventory of Chemical Substances (AICS) | Yes |
| Canada | Domestic Substances List (DSL) | Yes |
| Canada | Non-Domestic Substances List (NDSL) | No |
| China | Inventory of Existing Chemical Substances in China (IECSC) | Yes |
| Europe | European Inventory of Existing Commercial Chemical Substances (EINECS) | Yes |
| Europe | European List of Notified Chemical Substances (ELINCS) | No |
| Japan | Inventory of Existing and New Chemical Substances (ENCS) | Yes |
| Korea | Existing Chemicals List (ECL) | Yes |
| New Zealand | New Zealand Inventory | Yes |
| Philippines | Philippine Inventory of Chemicals and Chemical Substances (PICCS) | Yes |
| United States & Puerto Rico | Toxic Substances Control Act (TSCA) Inventory | Yes |

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

## 16. Other information, including date of preparation or last revision

**Issue date** 17-February-2014

**Revision date** -

**Version #** 01

**NFPA Ratings**

**List of abbreviations** LD50: Lethal Dose, 50%.
LC50: Lethal Concentration, 50%.

| | |
|---|---|
| **References** | Chemical safety report.<br>ECHA registered substances database |
| **Disclaimer** | This safety data sheet was prepared in accordance with the Safety Data Sheet for Chemical Products (JIS Z 7250:2005). The information contained herein is accurate to the best of our knowledge. However, data, safety standards and government regulations are subject to change and, therefore, holders and users should satisfy themselves that they are aware of all current data and regulations relevant to their particular use of product. CARUS CORPORATION DISCLAIMS ALL LIABILITY FOR RELIANCE ON THE COMPLETENESS OR ACCURACY OR THE INFORMATION INCLUDED HEREIN. CARUS CORPORATION MAKES NO WARRANTY, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OF MERCHANTIABILITY OR FITNESS FOR PARTICULAR USE OR PURPOSE OF THE PRODUCT DESCRIBED HEREIN. All conditions relating to storage, handling, and use of the product are beyond the control of Carus Corporation, and shall be the sole responsibility of the holder or user of the product.<br>(Carus and design) is a registered service mark of Carus Corporation. |

# APPENDIX B
# CASCADE TECHNICAL SERVICES INJECTION EQUIPMENT PHOTOGRAPHS

REVISED CAPITAL INDUSTRIES PLANT 4 STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

**1.** Street Work

**2.** Back of an Injection Rig w/ Spill Kits.

**3.** Rows of Points

**4.** Injection Rig Interior

**5.** Injection Rig Interior

**6.** Aerial Site View

# APPENDIX C
# SAMPLING AND ANALYSIS PLAN

REVISED CAPITAL INDUSTRIES PLANT 4 STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

# SAMPLING AND ANALYSIS PLAN
# APPENDIX C OF THE REVISED CAPITAL INDUSTRIES PLANT 4 STAGE 1 FIELD IMPLEMENTATION WORK PLAN

**West of 4th Group Site**
**Capital Industries, Inc.**
**5801 3rd Avenue South**
**Seattle, Washington**

**Submitted by:**
**Farallon Consulting, L.L.C.**
**975 5th Avenue Northwest**
**Issaquah, Washington 98027**

**Farallon PN: 457-008**

**For:**
**West of 4th Avenue Group**
**Site Unit 2 Joint Deliverable**
**Capital Industries, Inc.**
**Blaser Die Casting Co.**
**Stericycle**
**Seattle, Washington**

May 10, 2018

Prepared by:

Jennifer L. Moore
Senior Scientist

Reviewed by:

Jeffrey Kaspar, L.G., L.H.G.
Principal Geologist

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| bgs | below ground surface |
| CI | Capital Industries, Inc. |
| CVOCs | chlorinated volatile organic compounds |
| DOT | U.S. Department of Transportation |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| Farallon | Farallon Consulting, L.L.C. |
| ISCO | in-situ chemical oxidation |
| PNOD | permanganate natural oxidant demand |
| PVC | polyvinyl chloride |
| QA/QC | quality assurance/quality control |
| SAP | *Sampling and Analysis Plan*, *Appendix C of the Revised Capital Industries Plant 4 Stage 1 Field Implementation Work Plan, West of 4th Group Site, Capital Industries, Inc., 5801 3rd Avenue South, Seattle, Washington* dated May 10, 2018, prepared by Farallon Consulting, L.L.C. |
| Site | the West of 4th Group Site consisting of Site Unit 1 and Site Unit 2 |
| SOPs | standard operating procedures |
| SU2 | Site Unit 2 |

| | |
|---|---|
| WAC | Washington Administrative Code |
| Water Table Interval | approximately 20 feet below ground surface |
| West of 4th Group | Art Brass Plating, Inc.; Blaser Die Casting Co.; Capital Industries, Inc.; and Burlington Environmental, LLC |
| Work Plan | *Revised Capital Industries Plant 4 Stage 1 Field Implementation Work Plan, Site Unit 2, Seattle, Washington* dated May 10, 2018, prepared by Farallon Consulting, L.L.C. (this document) |

# 1.0 INTRODUCTION

Farallon Consulting, L.L.C. (Farallon) has prepared this Sampling and Analysis Plan (SAP) for Stage 1 of the Capital Industries Plant 4 interim action on behalf of Art Brass Plating, Inc.; Blaser Die Casting Co.; Capital Industries, Inc. (CI); and Burlington Environmental, LLC[1] (collectively referred to herein as the West of 4th Group), which are the potentially liable parties at the West of 4th Group Site (herein referred to as the Site). The Site consists of Site Unit 1 and Site Unit 2 (SU2) as depicted on Figure 1. The Art Brass Plating, Inc. property is located at Site Unit 1. The CI and Blaser Die Casting Co. properties are located at SU2. The CI property comprises five buildings identified as Plants 1 through 5 (Figure 2). The interim action at CI Plant 4 is being conducted on behalf of the West of 4th Group.

This SAP has been prepared in accordance with the requirements of Agreed Order No. DE 10402, entered into by the West of 4th Group and the Washington State Department of Ecology (Ecology) in April 2014; the First Amendment to Agreed Order No. DE 10402 dated November 20, 2017; and the Washington State Model Toxics Control Act Cleanup Regulation, as established in Chapter 173-340 of the Washington Administrative Code (WAC 173-340-350 and 173-340-820). This SAP is included as Appendix C of the *Revised Capital Industries Plant 4 Stage 1 Field Implementation Work Plan* (Work Plan) dated May 10, 2018, prepared by Farallon to present the specific requirements for installation of observation wells and soil and groundwater sampling during the interim action being conducted at CI Plant 4. The interim action being conducted at CI Plant 4 comprises in-situ chemical oxidation (ISCO) of soil in the vadose zone and groundwater to a depth of approximately 20 feet below ground surface (bgs), herein referred to as the Water Table Interval, using potassium permanganate.

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[1] Burlington Environmental, LLC, is a wholly owned subsidiary of PSC Environmental Services, LLC, which is a wholly owned subsidiary of Stericycle Environmental Solutions, Inc.

The interim action objectives are tied to the remedial action objectives for the Site, described in the West of 4th Site Unit 2 Feasibility Study prepared by the West of Fourth Group and Pacific Groundwater Group,[2] and include:

- Reducing concentrations of chlorinated volatile organic compounds (CVOCs) in soil beneath CI Plant 4 to concentrations less than the preliminary cleanup levels for the Site to reduce inhalation risks to acceptable levels; and
- Reducing concentrations of CVOCs in shallow groundwater that allegedly originated from CI Plant 4 to concentrations less than the preliminary cleanup levels for the Site.

The SAP presents specific methodologies for the collection, handling, and analysis of samples that will be conducted during the interim action in accordance with technically acceptable protocols that meet the data quality objectives defined in the Quality Assurance Project Plan that was prepared for the interim action, provided as Appendix D of the Work Plan.

The SAP provides standard operating procedures (SOPs) pertaining to sampling equipment, sample collection and handling, and the laboratory analyses that will be used for performance and confirmation soil sampling, well installation observation, and performance and confirmation soil and groundwater monitoring and sampling. The SAP provides a basis for planning field activities, and a mechanism for implementing quality assurance requirements.

## 1.1 PURPOSE

The purpose of the SAP is to:

- Provide the basis for conducting field activities to meet the scope of work described in the Work Plan;
- Identify proposed observation well locations and observation well installation, design, and development procedures;

---

[2] 2016. *West of Fourth Site Unit 2 Feasibility Study, Seattle, Washington* dated August 11, 2016 prepared for West of Fourth Joint Agreed Order, Art Brass Plating, Blaser Die Casting, Capital Industries, and Stericycle by West of Fourth Group and Pacific Groundwater Group.

- Describe the sampling protocols, analytical methods, and documentation for the sampling program; and
- Describe the equipment, procedures, and methodology to be used for soil and groundwater sample collection.

## 1.2 ORGANIZATION

The SAP is organized into the following sections:

- **Section 2, Sampling Objectives,** summarizes the objectives and scope of the sampling program associated with the interim action.
- **Section 3, Observation Well Installation and Soil and Groundwater Monitoring,** presents the details of the observation well installation and development, the soil sampling and groundwater monitoring and sampling activities, and pressure monitoring activities to be conducted for the high-pressure injection proximate to the east-adjacent property (Figure 3).
- **Section 4, Sampling Procedures and Designation,** details the sampling procedures and sample designation that will be used for soil sampling and groundwater monitoring and sampling.
- **Section 5, Laboratory Analyses,** presents the laboratory analytical work that will be conducted for performance and confirmation monitoring.
- **Section 6, Sample Handling,** presents details on soil and groundwater sample containers, preservation procedures, hold times, packaging, shipment, documentation, and field quality assurance/quality control (QA/QC) samples.
- **Section 7, Management of Investigation-Derived Waste,** presents details regarding the management of waste soil, wastewater, and disposables generated during the interim action.
- **Section 8, Field Documentation,** summarizes the field documentation procedures and the forms, labels, and other project records that will be used during implementation of the performance and confirmation monitoring program associated with the interim action.

# 2.0 SAMPLING OBJECTIVES

The sampling objectives for performance monitoring associated with Stage 1 of the interim action are to collect sufficient soil and groundwater data to demonstrate oxidant distribution and the effectiveness of the Stage 1 injections, and to assist with the design of Stage 2 injections. This SAP presents the specific requirements for observation well installation; soil sample collection; and groundwater monitoring and sample collection, handling, and analysis for the monitoring program associated with the interim action.

# 3.0 OBSERVATION WELL INSTALLATION AND SOIL AND GROUNDWATER MONITORING

This section describes observation well installation, boring advancement, groundwater monitoring, and pressure monitoring activities to be conducted. The soil and groundwater monitoring will be conducted in accordance with WAC 173-340-820 and the attached SOPs (Appendix A).

The soil sampling field program includes advancement of performance borings for visual observation of oxidant distribution and collection of performance soil samples to monitor the effectiveness of the Stage 1 injections. The groundwater monitoring field program includes monitoring geochemical parameters in groundwater, and collection of groundwater samples from observation and monitoring wells beneath CI Plant 4. Five 1-inch-diameter observation wells with pre-pack screens will be installed into the Water Table Interval using direct-push drilling methods to support performance groundwater monitoring activities. Prior to initiating observation well installation or advancement of borings, Farallon will review surface structures and as-built utility maps, if available, and will contact public and private utility location services to confirm the location of subsurface utilities. Observation well locations will be coordinated with CI personnel.

## 3.1 OBSERVATION WELL INSTALLATION AND DEVELOPMENT

Five new 1-inch-diameter observation wells will be installed inside CI Plant 4 (Figure 3). The observation wells will be advanced using direct-push drilling methods, and constructed in accordance with the SOPs provided in Appendix A. Installation and development of the observation wells will follow SOP GW-01 for well construction, and SOP GW-02 for well development. The observation wells will be constructed in accordance with WAC 173-160. Field equipment will be decontaminated between boring locations using the procedures described in SOP EQ-01 (Appendix A).

Each observation well will be constructed using 1-inch-diameter Schedule 40 polyvinyl chloride (PVC) well casing to a total depth of 18 feet bgs. The observation wells will be constructed with 10 feet of screen from the bottom of the well using 0.010-inch slotted Schedule 40 PVC pipe, with a pre-packed sand filter pack comprising 20/40 Silica Sand surrounded by 100 mesh stainless steel screen from the bottom of the screened interval to a few inches above the top of the screened interval. The annular seal between the boring and the 1-inch diameter PVC casing will be installed using 3/8-inch bentonite pellets with a minimum thickness of 3 feet, followed by pumping cement/bentonite grout (i.e., at least 6 percent high-yield bentonite powder mixed with Portland cement) into the annulus with a tremie pipe. The grout will be pumped into the borehole at least 30 minutes after the bentonite pellet layer has been installed. Each observation well will have a locking cap, and will be completed with flush-mounted traffic-rated 8-inch steel covers with security bolts. Monitoring well construction details will be documented in the field on a Monitoring Well Construction Data form (Appendix B).

The screened intervals and the total depth in each observation well will be designed to screen a discrete range in the Water Table Zone that is consistent with the other monitoring wells in this zone. The specific screened interval of each planned observation well was selected based on the screened intervals of existing Water Table Interval monitoring wells MW-6 and MW-7, which also will be included in the interim action compliance groundwater sampling program. Both monitoring wells MW-6 and MW-7 are constructed with well screens set at approximately 10 to 20 feet bgs. The locations and screened intervals of the planned observation wells combined with those of the existing monitoring wells will allow a comprehensive performance and confirmation groundwater monitoring program for the planned interim action.

Observation well development will be completed following installation to ensure removal of fine-grained sediment from the vicinity of the well screen. This procedure allows groundwater to flow freely into the observation well, and reduces the turbidity of groundwater during sampling. Well development will be conducted in accordance with the SOPs provided in Appendix A.

Decontamination water and purged groundwater generated during installation and development of the observation wells will be temporarily stored on the CI property pending receipt of laboratory analytical and waste profiling data. Decontamination water and purged groundwater generated during installation and development of the observation wells will be handled as described in Section 7.2, Wastewater.

Following installation of the observation wells, the top of the casing in each observation well will be surveyed relative to mean sea level. A professional surveyor licensed in the state of Washington will survey the horizontal and vertical location of the top of each well casing and the top of each monument relative to vertical datum NAVD88.[3]

## 3.2 SOIL SAMPLING

Performance soil samples will be collected from several borings advanced after the Stage 1 ISCO injections described in the Work Plan. Borings will be advanced using direct-push drilling techniques to a total depth a maximum of 2 feet deeper than the co-located ISCO injection point. Boring advancement and soil sampling will be conducted in accordance with the procedures summarized in Section 4.1.1, Soil Sampling and the SOPs provided in Appendix A.

## 3.3 GROUNDWATER MONITORING AND SAMPLING

Groundwater monitoring and sampling will be conducted at the five new 1-inch-diameter observation wells and existing monitoring wells MW-6 and MW-7 (Figure 3) as described in the Work Plan and in accordance with the procedures described in the SOPs provided in Appendix A. Groundwater samples collected from each observation and monitoring well will be analyzed as described in Section 4.1.2, Groundwater Monitoring and Sampling.

## 3.4 PRESSURE MONITORING PROXIMATE TO EAST-ADJACENT PROPERTY

The subslab vapor monitoring points used to monitoring the negative-pressure field applied beneath the building slab that were installed as part of the subslab depressurization system for the Pacific Foods Systems North Building will be monitored for pressure changes prior to and throughout the injection process at injection point C-5. The pressure changes before, during, and after the injection process will be evaluated for safety purposes and for the potential influence of the high-pressure injection process at this adjacent property.

Prior to injection at ISCO injection point C5, the subslab depressurization system will be turned off and the subsurface allowed to equilibrate for at least 30 minutes prior to obtaining baseline subslab pressure measurements at subslab monitoring ports SSMP-1 and SSMP-3 (Figure 3). Subslab pressure will be monitored every 30 to 60 minutes depending on back pressure

---

[3] North American Vertical Datum of 1988.

observations at the injection point. High back pressures will require more frequent monitoring and will be assessed in the field based on process monitoring at the injection point. Subslab pressures will be monitored using a low-range Dwyer magnehelic gauge with a range of 0 to 2 inches of water. The pressure data will be used collectively with the other process monitoring data to evaluate the injection radius of influence and potential safety concerns regarding higher pressure injection work.

# 4.0 SAMPLING PROCEDURES AND DESIGNATION

This section summarizes the procedures and designation protocols to be implemented for soil sampling and groundwater monitoring and sampling associated with Stage 1 of the interim action. Specific SOPs for each of the sampling procedures are provided in Appendix A. Examples of the forms that will be used to document the sampling procedures are provided in Appendix B.

## 4.1 SAMPLING PROCEDURES

The field sampling procedures for collecting and handling samples are described below, and discussed in detail in the SOPs (Appendix A).

### 4.1.1 Soil Sampling

Soil sampling will be conducted after completion of Stage 1 injections. Each soil sampling event will consist of the following elements:

- Utility clearance in accordance with the Health and Safety Plan provided as Appendix A of the Work Plan;
- Equipment decontamination in accordance with SOP EQ-01;
- Photoionization detector calibration and operation in accordance with SOP EQ-02;
- Preparation of field notes in accordance with SOP GN-01;
- Collection of soil samples from the core liner in accordance with SOP SL-01; and
- Handling and storage of investigation-derived waste in accordance with SOP WM-01.

During the Stage 1 work, a minimum of one soil sample per 5-foot depth interval exhibiting a pink or purple hue will be collected and submitted for analysis for potassium permanganate by Standard Method SM4500 to determine the concentration of potassium permanganate in soil. Additional soil samples may be analyzed based on observations of soil conditions at the time of drilling. Conditions that may warrant analysis of additional samples may include extreme differences in coloration in a sampling interval that would suggest the potential for a less-uniform oxidant demand or a distribution pattern related to the soil matrix composition. The data will be used collectively to evaluate oxidant demand and distribution potential beneath CI Plant 4, and will allow for a more-effective dosing and distribution during the Stage 2 injection program.

If potassium permanganate is not observed in a Stage 1 performance boring, one soil sample will be collected from each soil type and analyzed for potassium permanganate natural oxidant demand (PNOD) by ASTM International Method D7262-10, Test Method A (Appendix C). If soil exhibits no indications of potassium permanganate, one soil sample per sampling interval will be submitted for analysis also of CVOCs by U.S. Environmental Protection Agency (EPA) Method 8260D.

Soil samples will be collected using zero-headspace sample kits, where applicable, and placed into pre-cleaned laboratory-provided sample containers. Care will be taken to not handle the seals or lids of the containers when the samples are placed into the containers, and the seals/lids will be secured. Soil samples will be logged on a Chain of Custody form and placed into a chilled cooler at a temperature of approximately 4 degrees Celsius for transport to the laboratory under standard chain-of-custody protocols.

### 4.1.2 Groundwater Monitoring and Sampling

Groundwater monitoring and sampling will be conducted at the five new 1-inch-diameter observation wells and existing monitoring wells MW-6 and MW-7. Geochemical parameters, including temperature, pH, dissolved oxygen, oxidation-reduction potential, and specific conductance, will be measured in the field using a multiparameter meter. Each groundwater monitoring and sampling event will consist of the following elements:

- Equipment decontamination in accordance with SOP EQ-01;
- Preparation of field notes in accordance with SOP GN-01;
- Measurement of the depth to groundwater in accordance with SOP GW-03;
- Low-flow purging, field-monitoring of water-quality parameters, and collection of groundwater samples at each observation and monitoring well in the interim action monitoring program in accordance with SOP GW-04; and
- Handling and storage of investigation-derived waste in accordance with SOP WM-01.

During and immediately following the Stage 1injection, groundwater at observation wells OBW-1, OBW-3, and OBW-5 and monitoring wells MW-6 and MW-7 will be visually inspected for color, and compared to the chart in the RemOx Desk Reference (Appendix D) that correlates color with potassium permanganate concentration. Standard spectrophotometric methods using the Hach DR 890 (Appendix E) will be used to measure potassium permanganate concentrations. Concentration and color will be logged to document the distribution and concentration of potassium permanganate injected into the formation. If evidence of potassium permanganate is confirmed in the field, groundwater samples will not be collected for CVOCs. If there is no evidence of potassium permanganate in groundwater at monitoring well MW-7, a sample will be collected for analysis for hexavalent chromium to assess the potential formation and mobilization of this oxidation by-product. Standard Method SM3500-CR B is a colorimetric method; attempting to analyze a groundwater sample with potassium permanganate present would cause bias in the analytical result. If groundwater samples are collected and analyzed for CVOCs and/or metals, the samples will be "quenched" through application of ascorbic acid. The quenching process neutralizes residual oxidant present in the sample so reactions do not continue between the time of sample collection and analysis by the laboratory.

Groundwater samples will be collected from the 1-inch-diameter monitoring wells using a 1-inch bladder pump. Groundwater samples will be collected from monitoring wells MW-6 and MW-7 using a 2-inch diameter bladder pump. Groundwater samples will be decanted from the tubing directly into pre-cleaned laboratory-provided sample containers, which will be filled completely. Care will be taken to minimize turbulence, and to not handle the seals or lids of the containers when the samples are placed into the containers. The containers will be filled to eliminate headspace, and the seals/lids will be secured. Groundwater samples will be logged on a Chain of Custody form and placed into a cooler at a temperature of approximately 4 degrees Celsius for transport to the laboratory under standard chain-of-custody protocols.

Additional field and geochemical parameters that will be directly measured using field instruments during sample collection include turbidity, temperature, pH, dissolved oxygen, oxidation-reduction potential, and specific conductance. These parameters will be compared to future performance monitoring data to evaluate the effects of ISCO and the potential radius of influence.

## 4.2 SAMPLE DESIGNATION

Each soil and groundwater sample collected during groundwater monitoring will be assigned a unique sample identifier and number, which will be recorded in indelible ink on a label that will be affixed to the corresponding container immediately after sample collection. In addition to the sample identifier and number, the sample labels will include the following information: client name; project name and number; date and time of sample collection; sampler initials; analytical method; and analyte preservative(s), if any. The sample designation procedures for soil and groundwater samples collected during performance and confirmation monitoring are detailed below.

### 4.2.1 Designation Procedures for Soil Samples

The soil samples collected from the borings will be assigned a unique sample identifier that will include the components listed below:

- The boring identification based on the grid square name and the boring number in that grid square (e.g., A3-01);
- The depth of the soil sample interval in feet bgs represented as a decimal number to the tenths place (e.g., 1.0); and
- The sample date in MMDDYY format (e.g., 070118).

For example, a soil sample collected from the first boring advanced in grid square A3 at a depth of 1.0 foot bgs on July 1, 2018 would be numbered A3-01-1.0-070118. This sample identification will be placed on the sample label, the Field Report form, the Soil Sample Data log, and the Chain of Custody form (Appendix B).

### 4.2.2 Designation Procedures for Groundwater Samples

The groundwater samples collected from the observation and monitoring wells will be assigned a unique sample identifier that will include the components listed below:

- The well identification (e.g., MW-6); and
- The sample date in MMDDYY format (e.g., 070118).

For example, a groundwater sample collected from monitoring well MW-6 on July 1, 2018 would be numbered MW6-070118. The sample identification will be placed on the sample label, the Field Report form, and the Chain of Custody form.

# 5.0 LABORATORY ANALYSES

This provides the details of the laboratory analysis associated with the soil and groundwater performance monitoring activities that will be conducted to meet the requirements of the interim action and the Work Plan.

Performance soil and groundwater samples will be analyzed as follows:

| **Sample Type** | **Analysis** |
|---|---|
| Baseline Groundwater | • CVOCs by EPA Method 8260D<br>• Dissolved arsenic by EPA Method 200.8<br>• Dissolved and total chromium, manganese, cadmium, and lead by EPA Method 200.8<br>• Total and dissolved iron by EPA Method 6010D<br>• Total and dissolved mercury by EPA Methods 7470A/245.1<br>• Total dissolved solids by Standard Method SM2540C<br>• Hexavalent chromium by Standard Method SM3500-CR B (M-7 only) |

| | |
|---|---|
| Stage 1 Groundwater | • CVOCs by EPA Method 8260D<br>• Dissolved arsenic by EPA Method 200.8<br>• Dissolved and total chromium, manganese, cadmium, and lead by EPA Method 200.8<br>• Total and dissolved iron by EPA Method 6010D<br>• Total and dissolved mercury by EPA Methods 7470A/245.1<br>• Total dissolved solids by Standard Method SM2540C<br>• Hexavalent chromium by Standard Method SM3500-CR B (MW-7 only, if potassium permanganate is not present.) |
| Stage 1 Performance Soil | • CVOCs by EPA Method 8260C<br>• Potassium permanganate by Standard Method SM4500<br>• PNOD analysis by ASTM International Method D7262-10, Test Method A (select soil samples) |

The laboratory that will analyze the soil samples for potassium permanganate or PNOD is Carus Corporation of LaSalle, Illinois, the supplier of the potassium permanganate product, which is ISO 9001:2015 certified. The laboratory that will analyze the remaining samples collected during each performance soil and groundwater monitoring and sampling event is OnSite Environmental Inc.

of Redmond, Washington (OnSite), which is Ecology-certified, and meets Ecology and EPA QA/QC requirements. A copy of the Quality Assurance Manual, Revision No. 9.6 dated April 17, 2018 prepared by OnSite, which will be followed throughout the interim action, is on file at the Farallon office for review and reference. Ecology will have access to laboratory personnel, equipment, and records pertaining to sample collection, transportation, and analysis.

QA/QC samples will be collected to provide for data validation, as detailed in the Quality Assurance Project Plan. Details on the types and frequency of QA/QC samples are provided in Section 6.4, Field Quality Assurance/Quality Control Samples.

# 6.0 SAMPLE HANDLING

This section discusses the sample handling methods to be used for soil and groundwater monitoring and sampling. The protocols discussed include sample containers, preservation procedures, and hold times; sample packaging and shipment; sample documentation; and QA/QC samples. Additional details are provided in the SOPs provided in Appendix A.

Upon transfer of the samples to laboratory personnel or arrival of the samples at the laboratory, the laboratory will assume responsibility for custody of the samples. Laboratory personnel will document the status of the shipping and handling containers, and the laboratory will use its standard chain-of-custody procedures for tracking each sample through all stages of laboratory processing.

## 6.1 SAMPLE CONTAINERS, PRESERVATION PROCEDURES, AND HOLD TIMES

Sample container requirements for soil and groundwater sampling are based on the medium to be sampled and the type(s) of analysis to be performed. The containers, preservation procedures, and hold times for soil and groundwater are shown in Table 1 and follow standard laboratory protocols. Laboratory method detection limits and practical quantitation limits for analyses that will be conducted during Stage 1 of the interim action are also shown in Table 1.

## 6.2 SAMPLE PACKAGING AND SHIPMENT

Samples shipped for laboratory analysis will be packaged according to applicable regulations. Samples will be sealed in coolers and transported expeditiously to the analytical laboratory. The sampling team will ship samples for analysis by Carus Corporation via an overnight shipping carrier. The sampling team may transport the samples for analysis by OnSite from CI Plant 4 to the laboratory, or samples may be transported to the Farallon office in Issaquah, Washington for subsequent transport to the analytical laboratory via courier.

The following procedures will be used for sample packaging, and represent the minimum shipping and handling requirements:

- Sample labels will be affixed to corresponding sample containers at the time of sample collection.

- Sample bottle caps for soil samples to be analyzed for potassium permanganate will be sealed with electrical tape.
- Bubble-wrap bags or an equivalent will be used to protect glass sample bottles.
- Sample containers will be placed into a chilled cooler and checked against the Chain of Custody form to ensure that all samples are listed and are in the correct cooler.
- One copy of the Chain of Custody form will be detached and retained.
- Remaining paperwork will be sealed in a resealable plastic bag. The bag will be taped to the inside of the cooler lid.
- Two to four resealable bags will be filled with ice and/or chemical equivalent and included in the cooler shipment. Ice will be double-bagged in heavy-duty resealable bags.
- The cooler will be sealed with a Chain of Custody seal.
- The cooler will be taped shut using shipping tape.
- The laboratory address will be affixed to the cooler(s).
- Extraneous stickers will be removed from the cooler(s).
- Farallon's return address on the cooler(s) will be confirmed.

## 6.3 SAMPLE DOCUMENTATION

Sample containers will be adequately identified with a durable label, and the sample identification will be recorded on the Chain of Custody form, the Field Report form, and the Soil Sample Data Log (Appendix B). Additional sample documentation to be maintained by field personnel includes Logs of Boring, Monitoring Well Construction Data forms, Well Purging and Sampling Data forms, Waste Inventory Tracking Sheets, Chain of Custody seals, sample labels, and waste drum labels. Examples of these forms are included in Appendix B.

Sample containers will be labeled with the following information: client, project name and number, date and time sampled, sample identification, sampler's initials, analysis, and analyte preservative(s), if any. At the time of sampling, the appropriate sample containers will be selected and the sample number for each sample will be recorded on the Field Report form and the Soil

Sample Data Log for soil samples. Samples will be logged on the Chain of Custody form, information on the Chain of Custody form will be checked against sample summary log entries, and samples will be recounted before they are removed from the site to verify that no samples have been misplaced. The completed and signed Chain of Custody form will be placed in a resealable plastic bag and taped to the inside lid of the cooler. A Chain of Custody seal will be used to seal the cooler shut before shipping to ensure that no tampering occurs between the time the cooler is relinquished by field personnel and the time it arrives at the laboratory. The Chain of Custody seal will be attached so that it must be broken to open the shipping container.

Each Chain of Custody form will contain the following information: media, date, time sampled, sample identification and number, project name, project number, sampler's initials, and analyte preservative(s) if any.

## 6.4 FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Groundwater QA/QC samples will be collected to provide data validation as detailed in the Quality Assurance Project Plan (Appendix D of the Work Plan). The QA/QC samples will include a trip or transport blank and a field duplicate sample.

### 6.4.1 Trip and Temperature Blanks

Laboratory-supplied trip blanks will accompany soil and groundwater samples collected for analysis for CVOCs during performance monitoring events for the interim action. The trip blanks will serve the dual purpose of temperature blanks for the laboratory. The trip/temperature blank for soil samples will be analyzed for CVOCs by EPA Method 8260C to assess the integrity of the sample containers during transport. The trip/temperature blank for groundwater samples will be analyzed for CVOCs by EPA Method 8260D for the baseline sampling event, the first sampling event, and every other sampling event thereafter when CVOCs are analyzed.

A temperature blank will be prepared to accompany any soil samples submitted to Carus Corporation for analysis for potassium permanganate. The trip/temperature and temperature blanks will be checked for temperature by sample-receiving personnel at the laboratories to ensure that the soil and groundwater samples arrived at the correct temperature.

### 6.4.2 Field Duplicate Samples

Field duplicate samples will be collected during sampling for analysis for CVOCs to assess the precision of laboratory analytical and field sampling methods. Soil sampling is subject to potentially wide ranges of variability due to the heterogeneity of the sample and the limited mass of soil sampled. Conversely, a medium such as groundwater is not as susceptible to the effects of heterogeneity, and is a more-reliable medium for establishing measures of precision and/or accuracy. A limited number of co-located field duplicate soil samples will be collected and analyzed for CVOCs and/or potassium permanganate to confirm the distribution and effectiveness of the injections. One duplicate groundwater sample per Stage 1 groundwater monitoring event will be collected and analyzed for CVOCs.

### 6.4.3 Matrix Spike/Matrix Spike Duplicate Samples

Matrix spike and matrix spike duplicate samples are collected and analyzed as a part of the QA/QC program for a project to evaluate the relative percent difference between sample results. One matrix spike/matrix spike duplicate sample will be collected per batch of 20 or fewer samples.

# 7.0 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste soil, wastewater, and other products generated during the interim action may be contaminated, and will be containerized and properly disposed of pending receipt of analytical results. Specific criteria that will be used to manage investigation-derived waste, including the profiling and selection of an appropriate disposal option for each of the expected waste streams, are discussed below.

## 7.1 WASTE SOIL

Waste soil generated by the installation of observation wells and the advancement of performance borings will be placed into U.S. Department of Transportation (DOT)–approved 55-gallon drums provided by the drilling contractor pending analysis and profiling of the waste soil. The drums will be labeled with the content, date generated, origin, and generator information. Waste soil will be temporarily stored in the central waste storage area at the CI property, and will be tracked using a Waste Inventory Tracking Sheet (Appendix B).

No contaminated waste soil will remain at the CI property longer than 90 days after generation. Farallon will provide CI with bids for disposal based on the laboratory analytical data. The waste profiles will be provided to the selected landfill facility or permitted transport, storage, and disposal facility. Waste profiles and manifests will be forwarded to the generator for approval and signature prior to transport of the materials off the CI property. Waste soil will be removed in labeled DOT-approved containers by a licensed transporter. Documentation for waste soil disposal will be maintained in the project file.

## 7.2 WASTEWATER

Wastewater generated by equipment decontamination and well development and purging during the observation well installation and groundwater monitoring and sampling phases will be placed into DOT-approved 55-gallon drums for storage on secondary containment in the central waste storage area at the CI property. Wastewater will not remain on the CI property longer than 90 days after generation. Wastewater generated during the interim action will be tracked using a Waste Inventory Tracking Sheet.

Groundwater analytical data from the groundwater monitoring and sampling will be used to develop wastewater profiles. Farallon will provide CI with bids for disposal based on the laboratory analytical data. The waste profiles will be provided to the selected landfill facility or permitted transport, storage, and disposal facility. The waste profiles and manifests will be forwarded to the generator for approval and signature prior to transport of the wastewater off the CI property in labeled DOT-approved containers. Documentation for wastewater disposal will be maintained in the project file.

## 7.3 DISPOSABLES

Disposable personal protective clothing (e.g., Tyvek suits, rubber gloves, boot covers) and disposable sampling devices (e.g., plastic soil sample plungers) will be cleaned, placed into plastic garbage bags, and disposed of as nonhazardous waste.

# 8.0 FIELD DOCUMENTATION

Documentation of field activities will be provided on several field forms. Documentation generated during the field program will be retained in the project file, and included in the reports generated, as appropriate.

## 8.1 FIELD REPORT FORM

Field personnel will keep a daily field log on a Field Report form. Field notes will be as descriptive and inclusive as possible so as to allow an independent party to reconstruct the sampling situation from the recorded information. Language will be objective, factual, and free of inappropriate terminology. A summary of each day's events will be completed on a Field Report form. At a minimum, field documentation will include the date, job number, project identification and location, weather conditions, sample collection data, personnel present and responsibilities, field equipment used, and any activities performed in a manner other than as specified in the SAP. In addition, if other forms or documents are completed or used (e.g., Chain of Custody form), they will be referred to in and attached to the Field Report form, which will be signed by field personnel. An example of the Field Report form is included in Appendix B.

## 8.2 LOG OF BORING FORM

A Log of Boring form will be prepared by a Farallon Scientist for each direct-push boring used for soil sampling or observation well installation. The Log of Boring form includes a depiction and description of hydrologic conditions (if possible), lithologic descriptions using the Unified Soil Classification System (if possible), and information on the potential presence of contamination. Basic observation well construction information will be recorded on the Log of Boring form along with a drawing of the well construction. A copy of the Log of Boring form is included in Appendix B.

## 8.3 SOIL SAMPLE DATA LOG

A Soil Sample Data log will be prepared to track soil sample information, including the location, date, time, depth, staining, odor, photoionization detector readings, and sheen. A copy of the Soil Sample Data log is included in Appendix B.

## 8.4 MONITORING WELL CONSTRUCTION DATA FORM

A Monitoring Well Construction Data form will be prepared for each observation well installed by a Farallon Scientist. The form includes well construction details and development information for the observation well. A copy of the Monitoring Well Construction Data form is included in Appendix B.

## 8.5 GROUNDWATER LEVEL MEASUREMENT SUMMARY FORM

A Groundwater Level Measurement Summary Form will be used to record the well number, depth to groundwater, total well depth, and any other pertinent information such as well condition, or the presence of pink or purple coloration associated with the presence of potassium permanganate.

## 8.6 LOW-FLOW WELL PURGING AND SAMPLING DATA FORM

A Low-Flow Purging and Sampling Data form will be used to record the depth to groundwater prior to and during purging, well purging information, and other pertinent hydrologic measurements and supplementary information collected during groundwater sampling at each interim action observation and monitoring well during each groundwater sampling event. The form will be completed by a Farallon Scientist at the time of sample collection. A copy of a Low-Flow Well Purging and Sampling Data form is included in Appendix B.

## 8.7 WASTE INVENTORY TRACKING SHEET

A Waste Inventory Tracking Sheet will be used to document and track wastes generated during the interim action. The form will include information on the waste container, origin and type of waste, date generated, labeling on the waste container, date removed from the site, transporter, and disposal location. An example of the Waste Inventory Tracking Sheet is included in Appendix B.

## 8.8 SAMPLE LABELS

Sample labels are filled out in indelible ink and affixed to sample containers immediately after sample collection. The labels include the following information: client, project, sample identification and number, date and time sampled, analysis to be performed, and preservative(s) if any. An example of a sample label is included in Appendix B.

## 8.9 WASTE MATERIAL LABEL

A waste material label is filled out in indelible ink and affixed to a waste container immediately upon filling. The waste material label includes the following information: contents of the container with accumulation date, address where the waste was generated, and generator's name and contact information. An example of a waste material label indicating that the waste container is on hold pending analysis is included in Appendix B.

## 8.10 CHAIN OF CUSTODY

A Chain of Custody form is filled out by the field sampling team any time samples are collected, transferred, stored, analyzed, or destroyed. The form is designed to be an accurate written record that can be used to trace the possession and handling of a sample from the moment of its collection through analysis and reporting of analytical values.

All samples submitted to a laboratory are accompanied by the Chain of Custody form. This form is checked for accuracy and completeness, and then signed and dated by the laboratory sample custodian accepting the sample. At the laboratory, each sample is assigned a unique sequential laboratory identification number that is stamped or written on the Chain of Custody form.

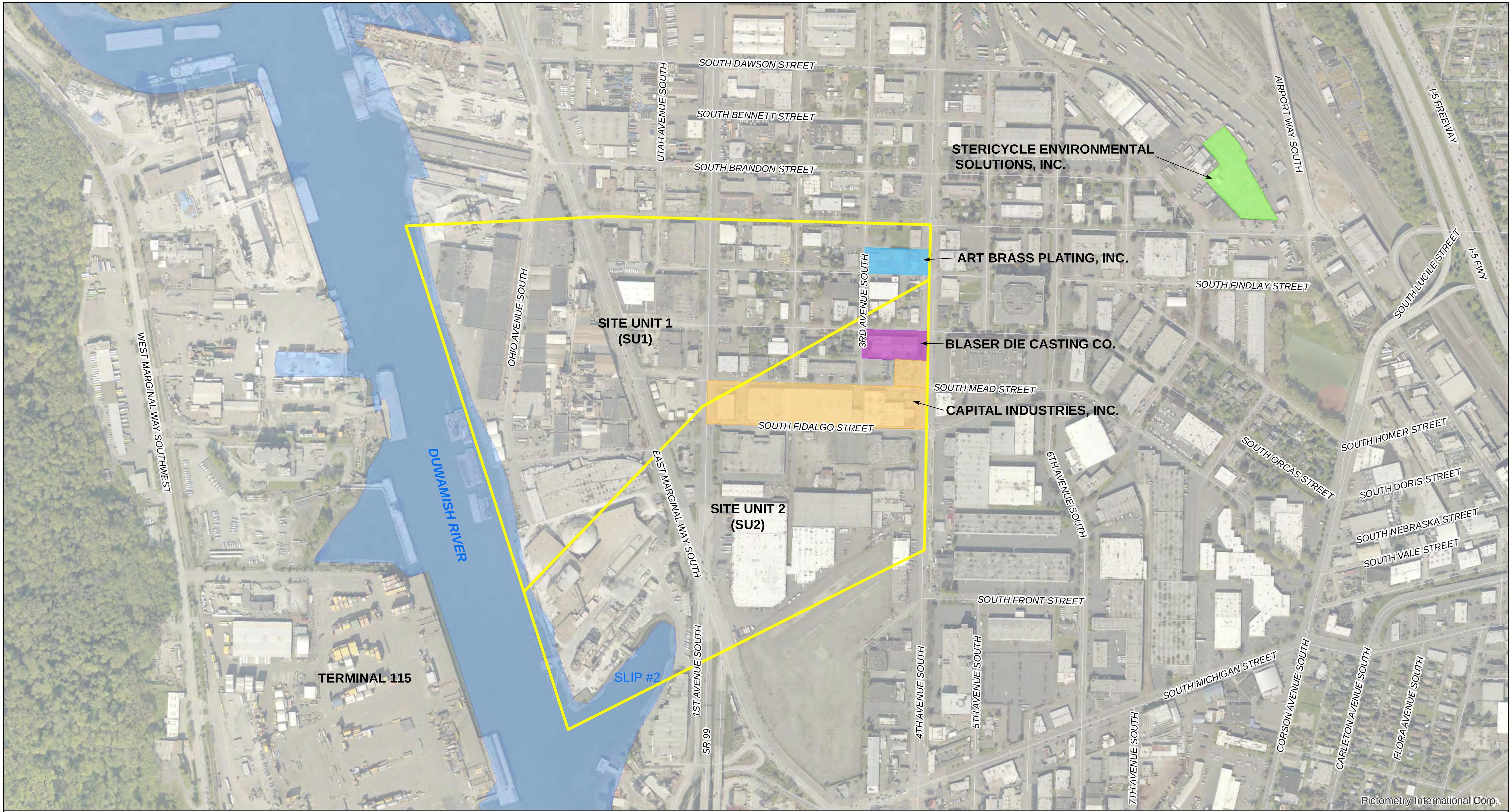
All samples are held under internal chain of custody in the Sample Control Room under appropriate storage conditions (e.g., ambient, refrigeration, frozen). The laboratory Project Manager assigned to a client is responsible for tracking the status of the samples throughout the laboratory. Samples are signed out of the Sample Control Room in a sample control logbook by the analyst who will prepare the samples for analysis.

The Chain of Custody form includes the following information: client, project name and number, date and time sampled, sample identification, sampler's initials, and analyses. Examples of a standard Chain of Custody form for OnSite and the Chain of Custody Record that will be used for samples submitted to Carus Corporation are included in Appendix B.

# FIGURES

SAMPLING AND ANALYSIS PLAN
APPENDIX C OF THE REVISED CAPITAL INDUSTRIES PLANT 4
STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
Capital Industries, Inc.
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008



LEGEND

| | |
|---|---|
| 🟦 | ART BRASS PLATING, INC. |
| 🟪 | BLASER DIE CASTING CO. |
| 🟧 | CAPITAL INDUSTRIES, INC. |
| 🟩 | STERICYCLE ENVIRONMENTAL SOLUTIONS, INC. |
| ☐ | SITE UNIT BOUNDARY |

N

0 250 500

SCALE IN FEET

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Issaquah | Bellingham | Seattle

Oregon
Portland | Bend | Baker City

California
Oakland | Folsom | Irvine

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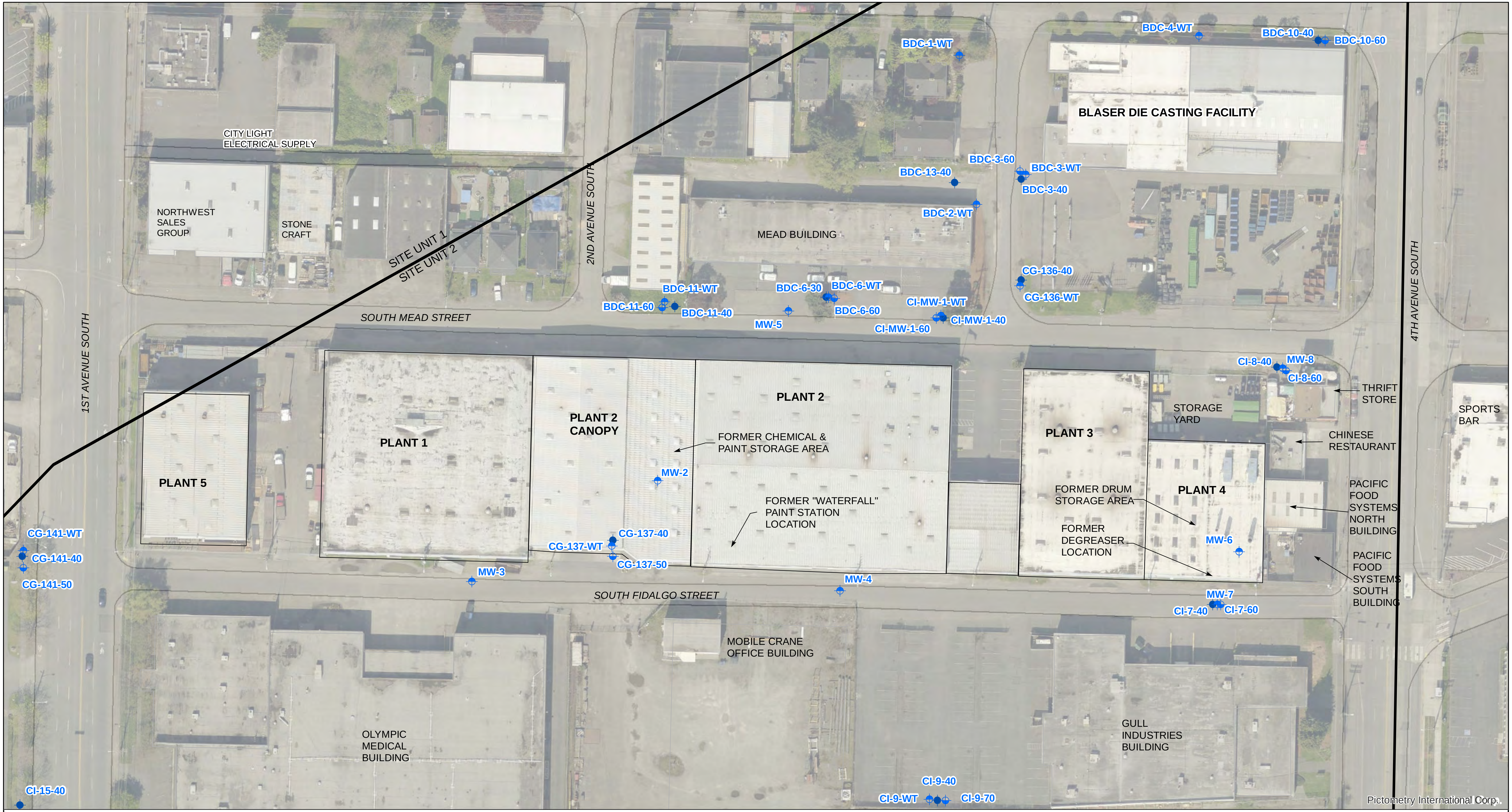
## FIGURE 1

SITE DIAGRAM
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5801 3RD AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: tperrin Checked By: JK Date: 5/7/2018 Disc Reference:

Document Path: Q:\Projects\457 CapitalIndust\008 PilotStudy\InterimWorkPlan\Revision_20180507\Figure1_Sitemap.mxd



LEGEND

| | |
|---|---|
| ⌖ | WATER TABLE INTERVAL MONITORING WELL |
| ● | SHALLOW INTERVAL MONITORING WELL |
| ⌖ | INTERMEDIATE INTERVAL MONITORING WELL |
| ▭ | SITE UNIT BOUNDARY |
| ▭ | BUILDINGS |

DRAFT

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0 40 80
SCALE IN FEET

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Oregon
Portland | Bend | Baker City

California
Oakland | Folsom | Irvine

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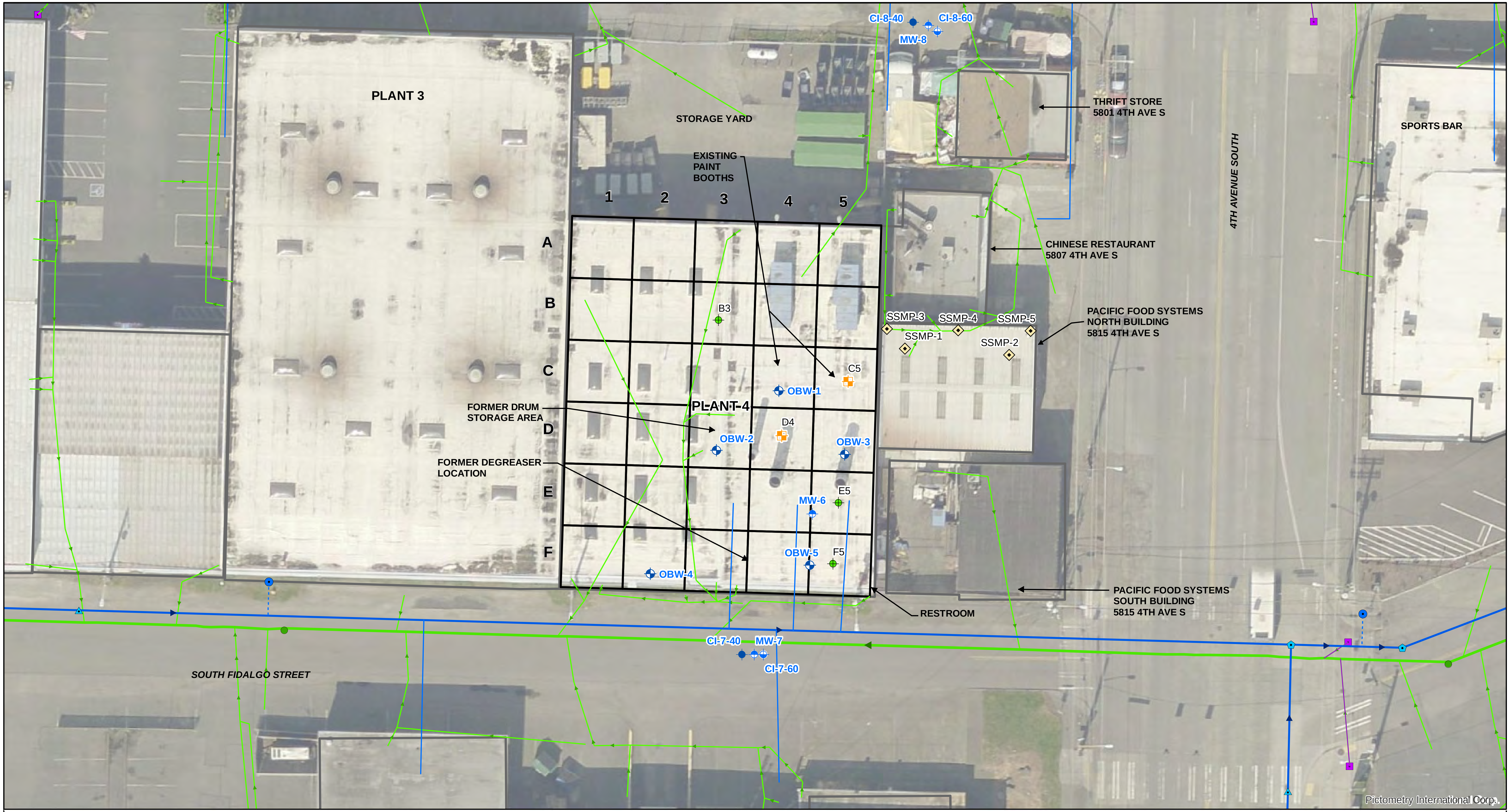
# FIGURE 2

PROPERTY DIAGRAM
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5801 3RD AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: tperrin
Checked By: JK
Date: 5/7/2018
Disc Reference:
Document Path: Q:\Projects\457 CapitalIndust\008 PilotStudy\InterimWorkPlan\Revision 20180507\Figure2 PropertyDiagram.mxd



LEGEND

- PROPOSED OBSERVATION WELLS
- WATER TABLE INTERVAL MONITORING WELL
- SHALLOW INTERVAL MONITORING WELL
- INTERMEDIATE INTERVAL MONITORING WELL
- STAGE 1 LOW-PRESSURE ISCO INJECTION POINTS
- STAGE 1 HIGH-PRESSURE ISCO INJECTION POINTS
- ◈ EXISTING SUBSLAB MONITORING PORT
- ● COMBINED SANITARY SEWER/STORMWATER MANHOLE
- COMBINED SANITARY SEWER/STORMWATER MAIN LINE AND FLOW DIRECTION
- SANITARY SEWER LATERAL AND FLOW DIRECTION
- ■ STORMWATER CATCH BASIN
- STORMWATER SIDE SEWER/LATERAL
- ☐ INJECTION GRID CELL
- ● HYDRANT
- ▲ WATER VALVE
- ⬟ WATER FITTING
- WATER DISTRIBUTION MAIN
- WATER SERVICE LINE
- HYDRANT LATERAL

ISCO = IN SITU CHEMICAL OXIDATION

DRAFT

NOTES: FEATURES DISPLAYED IN THE MAP EXTENT UTILIZE COLORS THAT MAY NOT BE VISIBLE IF PRINTED IN BLACK AND WHITE.

N

0 30
Scale in Feet

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Washington
Issaquah | Bellingham | Seattle

Oregon
Portland | Bend | Baker City

California
Oakland | Folsom | Irvine

## FIGURE 3

PLANT 4 STAGE 1 ISCO INJECTION
POINTS AND MONITORING WELLS
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5801 3RD AVENUE SOUTH
SEATTLE, WASHINGTON
FARALLON PN: 457-008

Drawn By: tperrin
Checked By: JM
Date: 5/8/2018
Disc Reference:
Path: Q:\Projects\457 CapitalIndust\008 PilotStudy\InterimWorkPlan\Revision_20180507\Figure5_ISCO_InjectionPoints_PMW.mxd

# TABLE

SAMPLING AND ANALYSIS PLAN
APPENDIX C OF THE REVISED CAPITAL INDUSTRIES PLANT 4
STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
Capital Industries, Inc.
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

# Table 1
# Analytical Details
## West of 4th Group Site
## Capital Industries, Inc.
## 5801 3rd Avenue South
## Seattle, Washington
## Farallon PN: 457-008

| Analyte | Analytical Method | Laboratory PQL | Laboratory MDL | Sample Container(s)/ Preservatives | Sample Hold Time |
|---|---|---|---|---|---|
| **Soil Samples (mg/kg)** | | | | | |
| Tetrachloroethene[1] | EPA 8260C | 0.001 | 0.000453 | 1 x 4-oz CWMJ unpreserved;<br>2 x 40-ml vials with a stir bar unpreserved; and<br>2 x 40-ml vials without a stir bar unpreserved | 14 days to analyze |
| Trichloroethene[1] | EPA 8260C | 0.001 | 0.000336 | | |
| cis-1,2-Dichloroethene[1] | EPA 8260C | 0.001 | 0.000236 | | |
| trans-1,2-Dichloroethene[1] | EPA 8260C | 0.001 | 0.000200 | | |
| 1,1-Dichloroethene[1] | EPA 8260C | 0.001 | 0.000209 | | |
| Vinyl Chloride[1] | EPA 8260C | 0.001 | 0.000316 | | |
| Potassium Permanganate[2] | Standard Method SM4500 | 0.36 | 0.11 | 1 x 40-ml vial unpreserved, sealed with electrical tape | 24 hours to analyze |
| Potassium Permanganate Natural Oxidant Demand[2] | ASTM Method D7262-10, Test Method A | 0.72 | 0.22 | 2 x 250-ml CWMJ unpreserved | 28 days to analyze |
| **Groundwater Samples [3]** | | | | | |
| Tetrachloroethene[1] | EPA 8260D | 0.20 | 0.0470 | 3 x 40-ml glass vials preserved with hydrochloric acid at pH<2 | 14 days to analyze |
| Trichloroethene[1] | EPA 8260D | 0.20 | 0.0535 | | |
| cis-1,2-Dichloroethene[1] | EPA 8260D | 0.20 | 0.0431 | | |
| trans-1,2-Dichloroethene[1] | EPA 8260D | 0.20 | 0.0558 | | |
| 1,1-Dichloroethene[1] | EPA 8260D | 0.20 | 0.0455 | | |
| Vinyl Chloride[1] | EPA 8260D | 0.20 | 0.0355 | | |
| Dissolved Arsenic[1] | EPA Method 200.8 | 3.0 | 0.0506 | Field Filter - 1 x 500-ml HDPE preserved with nitric acid with pH<2 or Lab Filter - 1 x 500-ml HDPE unpreserved | 6 months to analyze, 28 days for mercury |
| Dissolved Chromium[1] | EPA Method 200.8 | 10 | 0.0498 | | |
| Dissolved Manganese[1] | EPA Method 200.8 | 10 | 0.0247 | | |
| Dissolved Iron[1] | EPA Method 6010D | 56 | 10.200 | | |
| Dissolved Cadmium[1] | EPA Method 200.8 | 4 | 0.01 | | |
| Dissolved Mercury[1] | EPA Method 7470A/245.1 | 1.0 | 0.0216 | | |
| Dissolved Lead[1] | EPA Method 200.8 | 1.0 | 0.0116 | | |
| Total Chromium[1] | EPA Method 200.8 | 11 | 0.094 | 1 x 500-ml HDPE preserved with nitric acid with pH<2 | 6 months to analyze, 28 days for mercury |
| Total Manganese[1] | EPA Method 200.8 | 11 | 0.668 | | |
| Total Iron[1] | EPA Method 6010D | 56 | 30.8 | | |
| Total Cadmium[1] | EPA Method 200.8 | 11 | 0.1130 | | |
| Total Mercury[1] | EPA Method 7470A/245.1 | 0.50 | 0.00786 | | |
| Total Lead[1] | EPA Method 200.8 | 1.1 | 0.0813 | | |
| Total Dissolved Solids[1] | Standard Method SM2540C | 13.00 | NA | 1 x 250-ml HDPE unpreserved | 7 days to analyze |
| Hexavalent Chromium[1] | Standard Method SM3500-CR B | 10.00 | 2.66 | 1 x 500-ml HDPE unpreserved | 24 hours to analyze |

NOTES:

All samples must have a temperature of ≤ 6 degrees Celsius.

[1] The laboratory practical quantitation limits (PQLs) and method detection limits (MDLs) provided are from OnSite Environmental Inc. of Redmond, Washington.

[2] The laboratory PQLs and MDLs provided are from Carus Corporation of LaSalle, Illinois.

[3] Units of measure for groundwater samples are micrograms per liter (µg/l), except for total dissolved solids, which are measured in milligrams per liter (mg/l).

ASTM = ASTM International
CWMJ = clear wide-mouthed jar
EPA = U.S. Environmental Protection Agency
HDPE = high-density polyethylene
ml = milliliter
NA = not applicable

# APPENDIX A
# STANDARD OPERATING PROCEDURES

SAMPLING AND ANALYSIS PLAN
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Farallon PN: 457-008

# STANDARD OPERATING PROCEDURE GN-01
# FIELD NOTE PROCEDURES

## PURPOSE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide field personnel with the information needed to document site and sampling activities during field work. The step-by-step guidelines provided in this SOP are to be followed by the field personnel during field work.

## GENERAL FIELD NOTE INSTRUCTIONS

- Use a blue or black pen.
- Always document time in military time.
- Record your full name and the names of other Farallon employees present. Initials of personnel can be used after the full names have been provided in the field notes.
- Don’t leave line spaces between field note entries.
- Keep handwriting neat.
- Be concise.

## ITEMS TO INCLUDE IN FIELD NOTES

### At Start of Workday:

- Document when and where you started the field day and when you arrived at the site.
- Note any stops along the way to the site.

### Upon Arrival at Site:

- Note the reason for the site visit/site work.
- Document the weather on page 1, and throughout the day if the weather changes.
- Document the time personnel arrive at the site and the name of the company/agency they are affiliated with.
- Document the time subcontractors arrive, the tasks they are conducting, and the time they leave the Site.
- Conduct the Health and Safety (H&S) meeting, ensure all participants sign the H&S form, and include the signed H&S form in the field notes.
- Calibrate equipment: document equipment model number/serial number, calibration method, and results. Be specific (e.g., “Calibrated Horiba for pH using 4.0 standard.” “Calibrated PID using 100 ppm isobutylene span gas and ambient air as zero gas.”). Note whether the instrument is Farallon’s or a rental. If using a rental, include in the field notes the calibration sheet that should have come with the equipment. If using two sets of

equipment, note on the field forms which equipment was used for each location. For example, label "Horiba 1" and "Horiba 2" on the groundwater sampling sheets, and document the serial numbers of the instruments in the field notes. Make sure to document the calibration results for Farallon equipment in the Rite-in-the-Rain notebook kept in each field equipment case.

- Document when work starts at a specific task location (e.g., well or boring), and document what equipment Farallon or the subcontractors are using at that location.
- Measure out and record the sample locations (using a rolling wheel, or GPS if available), and mark utilities on a field map if applicable.
- If media samples will be collected, complete the appropriate documentation form, or record the information in the field notes. For example, record field sampling methods (e.g., grab, composite), the type of media (e.g., soil, groundwater, stormwater), the time the sample was collected, sample location and ID, analytical method(s), the laboratory conducting the analysis, the size of the sample container, the number of containers used, and the preservative included in the sample container. If a composite sample is collected, record how many composite points make up the sample, and document where the composite samples were collected.
- If multiple samples are collected using the same methods and the same type of sample containers, simply document that a sample was collected the same as previous samples.
- Document when work is complete at each location.
- If conducting groundwater monitoring, note the condition of monitoring well monuments (e.g., bolts missing, gasket needed).
- Throughout the workday, note any relevant information (e.g., QC-sampling discrepancies, unexpected conditions, abnormal sampling events).

### At End of Workday:

- Decontaminate equipment and note the decontamination method (e.g., Alconox and towels).
- Review the field notes, and complete sketches of any relevant features and sample locations if necessary.
- Record whether wastes were generated. If so, record how much was generated, whether the waste was sampled, and where the waste is stored.
- Place an "Analysis Pending" label on drums of waste, and fill out the label completely.
- Complete a drum inventory sheet and note the drum/container sizes and how much waste was accumulated.
- Document when you left the site;

- Document when you returned to the office or when the field day ended.
- Note any additional work performed after returning to the office (e.g., finished field notes, downloaded field photos).

**Make sure to include any of the following forms relevant for the type of field work conducted:**

- Daily Field Notes
- Health and Safety Meeting form
- Water Level Summary form
- Low Flow Well Purging and Sampling Data form
- Boring and/or test pit logs
- Monitoring Well Construction Data form
- Soil Sample Data form
- SVE Monitoring form
- Any site-specific operation and maintenance or pilot test forms
- Elevation Survey Data form
- Utility Clearance Log
- Waste Inventory Tracking Sheet
- Copy of the laboratory Chain of Custody form for any samples collected
- Copies of subcontractor daily log sheets (e.g., utility locate, drilling)
- Copies of rental equipment calibration sheets
- Near Miss form (if applicable)
- Incident Report form (if applicable)

**Assemble all field forms used each day, scan, save to the electronic project Field Notes folder, and give the hard copy of the forms to the Project Manager.**

*Refer to the Farallon Field Documentation Checklist* and the *Doc Reqs by Field Task list.*

# STANDARD OPERATING PROCEDURE EQ-01

# EQUIPMENT DECONTAMINATION PROCEDURES

## PURPOSE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide field personnel with the methodology for decontaminating sampling equipment during various field activities. The step-by-step guidelines provided in this SOP are to be followed by the field crew during all site visits, as applicable.

## EQUIPMENT AND SUPPLIES/REAGENTS

The following equipment is necessary to properly decontaminate field equipment during various field tasks:

- Rinse water or distilled water.
- Deionized water.
- Liquinox or other phosphate-free detergent.
- Paper towels.
- Labeled squirt bottles.
- Long-handled hard-bristle brushes (for sediment and soil).
- Cotton swabs.
- Plastic sheeting, garbage bags, and aluminum foil (for sediment and soil).
- Core liner caps or plastic wrap and rubber bands (for sediment and soil).
- Extension arm for cleaning core liners (for sediment and soil).
- Plastic 5-gallon bucket.
- U.S. Department of Transportation-approved drum(s) for decontamination water unless other water-handling arrangements have been made. Separate drums are needed for liquid and solid wastes (see Farallon SOP WM-01, Field-Handling of Investigation-Derived Waste). Liquid wastes should not be added to drums containing solid wastes.

Dilute Liquinox with distilled water in a squirt bottle in accordance with the instructions on the Liquinox package, and label the bottle. Fill another squirt bottle with distilled water, and label the bottle.

## FIELD EQUIPMENT TO BE DECONTAMINATED AFTER USE

Decontaminate the following field equipment at the conclusion of field work each day, in accordance with the procedures outlined in this SOP:

- Water-level meter.
- Horiba/YSI multiparameter probe.
- Bladder pump.
- Submersible pump.
- Sediment and soil collection and processing equipment.

## WATER-LEVEL METER DECONTAMINATION

Decontaminate the water-level meter after measuring the water level at a monitoring well before moving to a new monitoring well, using the following procedures:

- Spray the bottom half of a paper towel with the diluted Liquinox solution, and the upper half with deionized water.
- Grip the measuring tape of the water-level meter with the paper towel in one hand with the Liquinox side down toward the monitoring well casing.
- Begin slowly reeling up the water-level meter while maintaining firm contact between the measuring tape and the paper towel.
- Ensure that no debris or contamination remains on the measuring tape of the water-level meter once it has been reeled up.
- Use a clean new paper towel for each successive decontamination of the measuring tape of the water-level meter.

## HORIBA/YSI MULTIPARAMETER PROBE DECONTAMINATION

Decontaminate the Horiba/YSI multiparameter probe at the end of each workday or after sampling a monitoring well with high concentrations of contamination, using the following procedures:

- Remove the multiparameter probe from the flow-through cell, and thoroughly spray each component with deionized water.
- Use a cotton swab to gently clean around each sensor probe, ensuring that all contaminated water and material has been washed away.
- Refill the protective dissolved oxygen and pH probe caps with deionized water, and replace prior to storage.
- Once the multiparameter probe has been adequately cleaned, replace the protective shield, and return the probe to the case. If the device appears to be overly wet, allow it to air-dry with the case open.

- Do not use Liquinox to clean any probes on the Horiba multiparameter probe, as it may damage the device.

## BLADDER PUMP DECONTAMINATION

Decontaminate the bladder pump after sampling a well and at the end of each workday, using the following procedures:

- After extracting the bladder pump from the well, break down the pump, remove and dispose of the used bladder, and spray each component with the diluted Liquinox solution, followed by deionized water.
- Wipe away any visible contamination or debris with a paper towel.
- Capture cleaning water in a liquid waste drum for proper disposal in accordance with Farallon SOP WM-01, Field-Handling of Investigation-Derived Waste.
- Ensure that all contamination and Liquinox solution is washed off all components before reassembling the device, installing a new bladder, and moving to sample a new well.

## SUBMERSIBLE PUMP DECONTAMINATION

Decontaminate the submersible pump after purging water from any well, using the following procedures:

- After extracting the submersible pump from the well, thoroughly spray down the pump with the diluted Liquinox solution, followed by deionized water.
- Wipe away any visible contamination or debris with a paper towel.
- Purge clean water through the pump and tubing to ensure that contaminated water has been cleared from all lines.
- Capture cleaning water in a liquid waste drum for proper disposal in accordance with Farallon SOP WM-01, Field-Handling of Investigation-Derived Waste.

## SEDIMENT AND SOIL SAMPLING AND PROCESSING EQUIPMENT DECONTAMINATION

Decontaminate sampling equipment used to collect and process sediment and soil samples, using the following procedures:

- Place contaminated equipment and decontamination tools on plastic sheeting.
- Thoroughly rinse all used equipment with distilled water in a 5-gallon bucket to remove excess sediment or soil.
- Pour one capful of Liquinox solution into a 5-gallon bucket filled with tap water or distilled water.
- Using a long-handled hard-bristle brush, thoroughly scrub the equipment with the Liquinox solution until no sediment or soil particles remain.

- Holding the equipment over a 5-gallon bucket, double-rinse the equipment with distilled water until no Liquinox solution remains. Do not allow clean equipment to come into contact with a contaminated surface.
- Drain the equipment and place it in a clean, dry place to prevent recontamination.
- If decontaminated equipment will not be re-used immediately, wrap stainless steel equipment (e.g., bowls, spoons) in aluminum foil with the dull side facing the equipment. Seal polycarbonate core liners with core caps or cellophane plastic. Rubber-band ends to ensure a proper seal.
- After decontamination has been completed, place disposable items into a garbage bag, and store decontamination water in a drum in accordance with Farallon SOP WM-01, Field-Handling of Investigation-Derived Waste.

# STANDARD OPERATING PROCEDURE EQ-02

# PHOTOIONIZATION DETECTOR CALIBRATION AND OPERATION

## PURPOSE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide field personnel with the information needed to properly use, operate, and handle MiniRAE Photoionization Detector (PID) Models 2000 and 3000. The PID is used as a field-screening instrument for measurement of total volatile organic (TVO) concentrations in air. Typical uses include air monitoring of the breathing zone for health and safety purposes, screening of groundwater and soil for TVO emissions, and monitoring of the headspace of a monitoring well. The PID is a highly sensitive instrument. MiniRAE Models 2000 and 3000 have a potential operating range of 0.1 to 15,000 parts per million (ppm) isobutylene equivalents, depending on the lamp used. The detection limit is 0.1 ppm hexane or isobutylene, with a response time of less than 3 seconds.

Operation and maintenance manuals specific to this equipment should be referenced as necessary. Two user manuals are kept in Farallon's PID case: the *MiniRAE 3000 Pocket Reference;* and the *MiniRAE 3000 User's Guide*. These manuals should always be stored in the PID case so they are available for reference.

The step-by-step guidelines provided in this SOP are to be followed by the field crew when monitoring concentrations of TVO compounds in the breathing zone, a soil sample, a water sample, or the headspace of a monitoring well.

## EQUIPMENT

The following equipment is necessary to calibrate and operate the PID:

- The PID instrument;
- A calibration gas regulator and silicon tubing;
- Calibration gas containing approximately 100 ppm isobutylene; and
- A 110-volt battery charger.

## PID CALIBRATION CHECK

PID calibration should be checked at the beginning of the day, and as needed if drift occurs (see "PID Drift or Other Change" section below). The instructions below are to be followed to check PID calibration (refer to pages 17 and 18 of the *MiniRAE 3000 User's Guide* for information regarding the connection between buttons and control functions):

- Turn on the PID by pressing [MODE]. Wait for the PID to proceed to the default display, and allow the instrument to warm up for 10 minutes in accordance with the manufacturer's instruction. The initial reading should be 0 or 0.1 part per million volume (ppmv).
- Connect the regulator to the gas cylinder, and connect the tubing to the regulator.

- Start the gas flow by pushing in the regulator knob and turning 90 degrees. Some gas will begin to escape.
- Connect the tubing from the regulator to the PID sensor tip. The PID reading should climb to 99 to 101 ppmv.
- When the PID reading reaches the maximum level displayed, turn off the regulator and disconnect the sensor tip. The reading should return to zero.
- If any of the readings predicted above do not occur, re-calibrate the PID or arrange for repair.

## PID CALIBRATION

The instructions below are to be followed to perform a zero (fresh air) calibration and a span calibration on the PID (refer to pages 35 through 46 of the MiniRAE 3000 User's Guide for information regarding calibrations):

**Zero Calibration (**a zero calibration always should be performed prior to a span calibration):

- Turn the unit on by pressing [MODE] for approximately 1 second.
- Press and hold [MODE] and [N/-] simultaneously until you see the Password Screen.
- Input the password:
    - The default password is 0000.
    - Use the [Y/+] to increase the number value from 0 through 9.
    - Use the [N/-] to move the cursor to a different number slot.
    - Press [MODE] once you have input the password.
- Select "Calibration" by using [Y/+].
- Select "Zero Calib" by using [Y/+].
- Apply a fresh air source to the unit. Clean ambient air without detectable contaminants may be used as a fresh air source.
- Press [Y/+] to start the zero calibration. The zero calibration will take approximately 30 seconds to complete.
- The display screen will return to the Calibration menu when the zero calibration is complete.
- Record the values read by the PID in a calibration book or in the Log Field Book.

Once the zero calibration is complete, the unit automatically returns to the Calibration menu.

If the PID does not read 0.0 ppmv following the zero calibration, repeat the zero calibration procedure. If the PID fails both attempts to zero calibrate, move on to span calibration.

## SPAN CALIBRATION

- Press [N/-] to scroll down to “Span Calib.”
- Press [Y/+] to select “Span Calib.”
- Select the proper calibration gas. Ensure that the calibration gas and the span value on the unit’s display screen have the same TVO concentration.
- Connect the regulator to the gas cylinder, and connect the tubing to the regulator.
- Press [Y/+] to begin the span calibration.
- Immediately apply the correct calibration gas to the unit’s probe by turning the regulator knob 90º in either direction. The span calibration will take approximately 30 seconds.
- The calibrated value should be +/- 2 percent of the concentration indicated on the calibration gas canister. Once the span calibration is complete, the unit will automatically return to the calibration menu.
- If the calibrated value is 2 percent greater than the concentration indicated on the calibration gas canister, repeat the span calibration procedure.
- Press [MODE] twice to navigate back to the main display.
- When calibrating the PID with isobutylene, record values read by the PID in a calibration book or in the Log Field Book.
- If the PID did not initially calibrate using the zero calibration mode, re-attempt to calibrate the PID using fresh air.

If the PID does not calibrate using the span calibration gas, call and update the Project Manager on the status.

## PID DRIFT OR OTHER CHANGE

PID drift commonly is a failure of the instrument to return to zero after TVO concentrations dissipate. A failure to return to zero usually reflects inaccuracy at the upper end of the instrument’s detection range. Several situations can cause drift, including soil or water in the tip of the probe, soil or water in the sensor filter, or a change such as tightening or loosening the probe tip assembly since the instrument was last calibrated. The degree of drift from the initial daily calibration can be checked by exposing the PID to the calibration gas (see the “PID Calibration” section above). Re-calibration serves little purpose until the cause of the drift is determined.

If you determine that PID drift is occurring, complete the following actions:

- Unscrew the probe from the PID unit;
- Inspect the probe and the top of the unit for soil or moisture;
- Carefully remove any soil or moisture from the probe and/or unit by air drying;

- Replace the sensor filter on the probe with a new, unused sensor filter;
- Screw the probe back on the unit; and
- Apply Span Calibration gas to test the accuracy of the PID unit.

## PID OPERATION

The instructions below are to be followed for PID use to screen soil and groundwater for TVO concentrations, to monitor the breathing zone for health and safety purposes, and to monitor monitoring well headspace:

- Connect the PID sample probe with filter to the PID hand-held air monitor.
- Turn on the PID by pressing [MODE]. Wait for the PID to proceed to the default display, and allow the instrument to warm up for 10 minutes in accordance with the manufacturer's instructions.
- **CAUTION!** Do not seal the soil in a plastic bag for longer than 5 minutes when conducting soil screening to avoid false readings due to moisture build-up (in wet situations, use the filter on the end of the sensor tip). Pierce the plastic bag with a clean tool, and immediately insert the sensor tip, quickly establishing a tight seal. The meter should react rapidly. Record the maximum value displayed within 30 seconds.
- To monitor groundwater and soil for TVO emissions, place the probe inlet near the groundwater or soil surface, and read the meter display showing detected concentrations. Do not allow water or soil to be sucked into the instrument.
- To monitor the breathing zone for health and safety purposes, allow the PID to monitor air quality at the breathing zone, chest, or face level, and read the meter display showing detected concentrations.
- Monitor the headspace of a monitoring well directly after the well has been opened. Place the probe inlet directly above the polyvinyl chloride well casing or tubing that is associated with a dedicated pump in the well. Read the meter display showing detected concentrations.
- Ensure that the PID is kept dry while in use. Humidity or moisture from rain can cause large fluctuations in PID readings, and can damage the instrument.
- If the PID displays erratic readings, it is possible that either moisture or dirt is in the probe, or dirt has collected in the filter. If this occurs, clean and dry the sample probe (possibly by placing it near a running heater in a vehicle), and replace the filter if necessary.

## DOCUMENTATION

Document the PID measurements for all monitoring events on field forms and in a detailed field notebook, and record observations of varying weather conditions such as temperature and humidity fluctuations.

## REFERENCES

PE Photovac Air Monitor/Portable Photoionization Detector Model 2000/3000 Manuals.

RAE Systems.  2010.  *MiniRAE 3000 Pocket Reference.*  PN: 059-4030-000-D.  August.

———.  2010.  *MiniRAE 3000 User's Guide.*  P/N 059-4020-000.  August.

# STANDARD OPERATING PROCEDURE GW-01

# MONITORING WELL CONSTRUCTION

## PURPOSE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide field personnel with the methodology for monitoring well construction and installation. Monitoring well construction ultimately is at the discretion of the Project Manager, and is based on the geology at the site and the use of the monitoring well. Groundwater monitoring wells in the Puget Sound region, for example, typically are constructed using 2-inch-diameter Schedule 40 polyvinyl chloride well casing with 0.010-inch slotted screens because of the finer-grained materials prevalent in the region. Slot and sand sizes may be increased at the discretion of the Project Manager, depending on local geology. Monitoring wells must be installed and decommissioned by a licensed well driller, and constructed in general accordance with Chapter 173-360, Minimum Standards for Construction and Maintenance of Wells, of the Washington Administrative Code in Washington; with Rule 0410 of Division 240 of Chapter 690, Well Construction Standards – General, of the Oregon Administrative Rules in Oregon; with Bulletins 74-81 and 74-90, California Well Standards, from the California Department of Water Resources in California; and with the federal and/or state standards established for well construction specified in the project-specific field sampling plan in other states.

## EQUIPMENT AND SUPPLIES/REAGENTS

The following equipment is necessary for the construction and installation of monitoring wells:

- Monitoring well construction equipment (e.g., water-level meter, photoionization detector, tape measure, camera, plastic sheeting), as applicable.
- Monitoring well construction materials (e.g., well casing [screened and blank], filter pack sand, bentonite and/or Volclay Grout annular seal material, concrete, locking casing cap, well-head monument [flush-mounted or stove-pipe monument, as appropriate] complete with locking top, bollards for placement around well-head monument as applicable), provided by the driller.
- Materials necessary to provide required documentation, including Boring Log, Monitoring Well Construction Data form, and Field Report form.
- Personal protective equipment as described in the site-specific Health and Safety Plan.
- Decontamination equipment as specified in Farallon SOP EQ-01, Equipment Decontamination Procedures.
- U.S. Department of Transportation-approved drum(s) for decontamination wastewater and excess soil cuttings. Separate drums are needed for liquid and solid wastes (refer to Farallon SOP WM-01, Field-Handling of Investigation-Derived Waste). Liquid wastes should not be added to drums containing solid wastes.

## DECONTAMINATION

Before arrival at the site, upon relocation at the site, and upon demobilization from the site, decontaminate equipment that will come into contact with potentially contaminated soil and groundwater, in accordance with Farallon SOP EQ-01, Equipment Decontamination Procedures.

## PROCEDURES

Follow the instructions below for monitoring well construction and installation:

- Don appropriate personal protective equipment as described in the site-specific Health and Safety Plan.
- Before installing the casing, discuss the geology and groundwater conditions at the site with the Project Manager to confirm the depth the monitoring well screen should be placed at, and the length of screen to be used.
- Measure the depth to the bottom of the borehole to calculate the appropriate placement and length of the screened interval, filter pack, annular seal, and concrete surface seal. Calculate the approximate volumes of the filter pack and the seal material required for the specific monitoring well bore annulus and monitoring well casing diameter. Ensure that the filter pack extends from the bottom of the monitoring well intake to approximately 2 to 5 feet above the top of the monitoring well intake, and is approximately 2 to 4 inches thick. The monitoring well casing should be centered in the borehole. Ensure that the annular seal is a minimum of 2 feet thick above the top of the filter pack, and that the concrete seal is a minimum of 2 feet in depth from the surface.
- Prior to installation, measure and check the lengths of the monitoring well screen and the blank casing, and confirm the slot size and the sand filter pack size, the type of bentonite seal and/or Volclay Grout seal, and the monitoring well-head monument. For boreholes completed to depths deeper than the planned installation depth of the monitoring well casing, backfill the borehole with bentonite, sand, or pea gravel. Record the type and brand of the monitoring well construction materials used on a Monitoring Well Construction Data form.
- Record on a Field Report form the start and completion times for the various stages of monitoring well construction such as installation of the monitoring well casing into the borehole, filter pack and seal emplacement, and well-head monument placement.
- Record on a Monitoring Well Construction Data form the volumes of filter pack, the bentonite seal, and the concrete used to construct the monitoring well, and check against calculated volumes to confirm proper placement and amount. During the construction process, record any irregularities such as bridging of the filter pack or seal material that could indicate construction problems.
- Upon completion of monitoring well installation, measure the total monitoring well depth and the depth to groundwater, and record the measurements on the Monitoring Well Construction Data form.

- Place a mark or notch on the northern side of the top of the monitoring well casing to provide a monument for the measurement of water levels.

## DOCUMENTATION

Document monitoring well construction activities on the Monitoring Well Construction Data form and the Field Report form.

## REFERENCES

U.S. Environmental Protection Agency. 1991. *Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells*. EPA160014-891034. March.

———. 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. EPA/540/S-95/504. April.

# STANDARD OPERATING PROCEDURE GW-02

# MONITORING WELL DEVELOPMENT

## PURPOSE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide field personnel with the methodology for monitoring well development. All monitoring wells should be developed to create an effective filter pack around the monitoring well screen, rectify damage to the formation caused by drilling, remove fine particulates from the formation near the borehole, and assist in restoring the natural water quality of the aquifer in the vicinity of the monitoring well. The step-by-step guidelines provided in this SOP are to be followed by the field crew performing or overseeing monitoring well development.

## EQUIPMENT AND SUPPLIES/REAGENTS

The following equipment is necessary to properly develop a groundwater monitoring well:

- Monitoring well key, socket wrench or speed wrench, socket set, padlock key, or other monitoring well-access equipment.
- Electric water-level meter long enough to reach the bottom of the monitoring well, calibrated to 0.01 foot.
- Two-inch-diameter (or appropriately sized) surge block.
- Monitoring well-purging equipment (e.g., silicone line, polyvinyl chloride pipe, plug, submersible or non-submersible pump, tubing, power supply, extension cord), as applicable.
- U.S. Department of Transportation-approved drum(s) for decontamination wastewater unless other water-handling arrangements have been made. Separate drums are needed for liquid and solid wastes (see Farallon SOP WM-01, Field Handling of Investigation-Derived Waste). Liquid wastes should not be added to drums containing solid wastes.
- Materials necessary to provide required documentation (e.g., Field Report form, Monitoring Well Construction Data form, and Waste Inventory Tracking Sheet).
- Personal protective equipment as described in the site-specific Health and Safety Plan.
- Decontamination equipment as specified in Farallon SOP EQ-01, Equipment Decontamination Procedures.

## DECONTAMINATION

Before arrival at the site, upon relocation at the site, and upon demobilization from the site, decontaminate equipment that will come into contact with groundwater, in accordance with SOP EQ-01, Equipment Decontamination Procedures.

## PROCEDURES

Follow the instructions below for each monitoring well:

- Don appropriate personal protective equipment as described in the site-specific Health and Safety Plan.
- Brush away soil and vegetation, and pump standing water away from the monitoring well opening.
- Open the monitoring well cap.
- Measure the depth to water and the total depth of the monitoring well to the nearest 0.01 foot using a decontaminated water-level meter in accordance with Farallon SOP GW-03, Groundwater Level Measurements in Monitoring Wells. Record the measurements on the Monitoring Well Construction Data form.
- Calculate the unit purge volume using the formula and the input values from the table below:

$$V = [X(\mathit{monitoring\ well\ depth} - \mathit{water\ level})] + [Y(\mathit{monitoring\ well\ depth} - \mathit{bottom\ of\ seal\ or\ water\ level, whichever\ is\ lowest\ in\ depth})]$$

Where:
V = monitoring well volume, including annular space
X = internal casing volume per unit length (gallons per linear foot)
Y = annular volume per unit length (gallons per linear foot)

| Borehole Diameter (inches) | Casing Diameter (inches) | $\text{Volume}_{\text{casing}}$ (X) (gallons per linear foot) | $\text{Volume}_{\text{annulus}}$ (Y) (gallons per linear foot) |
|---|---|---|---|
| 7 | 2 | 0.17 | 0.68 |
| 8 | 2 | 0.17 | 0.98 |
| 10 | 4 | 0.65 | 1.34 |
| 12 | 4 | 0.65 | 2.07 |
| 12 | 6 | 1.47 | 1.70 |
| 14 | 8 | 2.61 | 1.98 |

## Development Procedures – Existing and New Monitoring Wells

Existing wells in a monitoring well network may require redevelopment if an excessive amount of fines are present in the monitoring well casing that could interfere with stabilization of water-quality parameters or collection of representative water-quality samples.

The instructions below are to be followed for development of existing and new monitoring wells:

**For existing monitoring wells only:**

- Remove the pump and/or any dedicated tubing from the monitoring well.

**For existing and new monitoring wells:**

- Attach one length of twine to the decontaminated surge block (or use a drill rig or tripod) and lower the surge block to within 0.25 foot of the bottom of the monitoring well.
- Surge the monitoring well by vigorously moving the surge block up and down from 0.25 foot from the bottom of the monitoring well to 1 foot above the top of the screened interval for a minimum of 5 minutes to create a surging action across the screened interval, which will bring finer-grained material into suspension. Move the surge block up and down in 3-foot sections until the entire monitoring well screen length has been surged. Record on the Monitoring Well Construction Data form the number of times the surge block is raised and lowered, and total surge time.
- Remove the surge block.
- If a submersible pump is to be used for monitoring well development, gently lower the pump into the monitoring well to within 1 foot of the bottom of the screened interval. If a non-submersible pump is to be used, lower the tubing to within 1 foot of the bottom of the screened interval.
- Begin purging the monitoring well at a rate sufficient to remove fines without pumping the monitoring well dry. Record on the Monitoring Well Construction Data form the volume of water pumped from the monitoring well.
- Surge and pump the monitoring well, including saturated annular space, a minimum of three and a maximum of five monitoring well volumes. If the monitoring well runs dry, let the monitoring well recharge. Then commence purging until a minimum of three monitoring well volumes have been purged. If this event is the first time the monitoring well has been developed and water was added during the drilling process, remove the volume of water introduced during drilling and monitoring well construction. Purging has been completed when *one* of the following has occurred:
    - The minimum purge volume has been removed; OR
    - Five purge volumes and the drilling process water volume have been removed.
- Measure the total depth of the monitoring well after development, and record on the Monitoring Well Construction Data form the total volume of water pumped from the monitoring well.
- Record on the Monitoring Well Construction Data form a description of the suspended particle content, and additional information such as unique odor or water color.

- Containerize the purge water in a U.S. Department of Transportation-approved drum(s) unless other water-handling arrangements have been made. Separate drums are needed for liquid and solid wastes (refer to Farallon SOP WM-01, Field-Handling of Investigation-Derived Waste). Liquid wastes should not be added to drums containing solid wastes.
- Upon completion of monitoring well development, properly seal, secure, and label the drums in accordance with Farallon SOP WM-01, , Field-Handling of Investigation-Derived Waste. Record the number and contents of the drums on a Waste Inventory Tracking Sheet. At a minimum, the drum label(s) should include:
    - Boring/monitoring well ID.
    - Facility name.
    - Drum contents.
    - Date.
    - Drum number.
- Close the monitoring well and record any monitoring well-integrity concerns on the Field Report form and the Monitoring Well Construction Data form.
- Decontaminate all equipment in accordance with Farallon SOP EQ-01, Equipment Decontamination Procedures.

## DOCUMENTATION

Document monitoring well development activities on the Monitoring Well Construction Data form. Record the number and contents of the drums on a Waste Inventory Tracking Sheet.

## REFERENCE

U.S. Environmental Protection Agency. 1991. *Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells.* Document No. 160014-891034. March.

# STANDARD OPERATING PROCEDURE GW-03

# GROUNDWATER LEVEL MEASUREMENT IN MONITORING WELLS

## PURPOSE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide field personnel with the methodology for measuring and documenting the depth to groundwater in monitoring wells. The step-by-step guidelines provided in this SOP are to be followed by the field crew to ensure consistent and representative measurements of depth to groundwater in monitoring wells. When multiple wells are present at a site, all water-level measurements typically are taken as quickly as possible to aid in the creation of potentiometric surface maps that are representative of a “single” point in time.

## EQUIPMENT AND SUPPLIES/REAGENTS

The following equipment is necessary to properly measure the depth to groundwater in monitoring wells:

- Monitoring well key, hand drill, socket set, Allen wrench, speed handle, padlock key, or other monitoring well-access equipment specific to the monitoring well monument cover plate.
- Electronic water-level meter (Solinst or equivalent) narrow enough to fit in the monitoring well, calibrated to 0.01 foot, with sufficient line to reach the bottom of the monitoring well.
- Oil-water interface probe, if light nonaqueous-phase liquid (LNAPL) is known or suspected to be present.
- Disposable bailer if LNAPL is known or suspected to be present, and the Project Manager requests that LNAPL be bailed from the well.
- Tape measure.
- Materials necessary to provide required documentation, including Groundwater Level Measurement Summary Forms and Field Report forms.
- Personal protective equipment as described in the site-specific Health and Safety Plan.
- Decontamination equipment as specified in Farallon SOP EQ-01, Equipment Decontamination Procedures.

## DECONTAMINATION

Before arrival at the site, upon relocation at the site, and upon demobilization from the site, decontaminate equipment that will come into contact with groundwater, in accordance with Farallon SOP EQ-01, Equipment Decontamination Procedures.

## PROCEDURES

Follow the instructions below for measuring water levels at each monitoring well:

- Don appropriate personal protective equipment as described in the site-specific Health and Safety Plan.
- Check the operation of the water-level meter by turning on the indicator switch and pressing the test button.
- Remove soil or vegetation from the monitoring well site.
- Open the monitoring well-head enclosure, and use a bilge pump or cup to remove standing water inside the monitoring well monument before opening the monitoring well cap. Dispose of standing water to the ground surface.
- Open the monitoring well cap.
- Monitor air quality at the monitoring well-head if volatile contaminants are suspected to be present, or if it is unknown whether volatile contaminants are present.
- Repeat above procedure until all monitoring wells are open.
- Allow the water level to equilibrate with ambient atmospheric pressure for approximately 15 minutes before measuring.
- Before taking any measurements, carefully measure the length of the sonde to the nearest 0.01 foot. The additional 2 to 3 inches from the zero point of the sonde to the tip of the sonde **must be discounted** for **all** total depth measurements.
- Measure and record the depth to water using a water-level meter that has been decontaminated in accordance with Farallon SOP EQ-01, Equipment Decontamination Procedures. With the water-level meter turned on to a medium level of sensitivity, slowly lower the meter into the monitoring well casing until it reaches the groundwater table. The probe will beep when it reaches the interface of the groundwater table (when the electronic circuit is first completed). Stop lowering the probe, hold the graduated water-level cable to the notch or mark on the northern side of the top of the monitoring well casing, and note the length measurement. Repeat this process to collect a second water-level measurement. If the two readings differ by more than 0.01 foot, repeat the measurements until the readings stabilize. Repeat the process until three consecutive stabilized readings have been measured. Record the water-level measurement **only** in relation to the probe being lowered into the monitoring well, *not* as it is raised out of the monitoring well. If you cannot see the top of the monitoring well casing when the water level beeps, grasp the tape with your thumb and index finger exactly at the measuring point corresponding with the notch or mark at the top of the monitoring well casing. Slowly pull the cable out of the monitoring well and read the measurement. Repeat until readings stabilize.
- Remove the cable from the monitoring well, and record the stabilized depth-to-water measurement on the Groundwater Level Measurement Summary Form to the nearest 0.01 foot.

- Measure the total monitoring well depth. **NOTE:** If groundwater samples are to be collected, measure the total monitoring well depth **after** all groundwater samples have been collected, to avoid resuspension of settled solids in the monitoring well, impacting the samples. If the monitoring well does not have a dedicated pump, lower the water-level indicator probe to the bottom of the monitoring well to measure the total depth of the monitoring well. Gently bounce the probe on the monitoring well bottom, and pull the slack in the cord to read the total monitoring well depth. Repeat three times to ensure that the monitoring well depth measurement is reproducible, and is representative of the true depth. Note on the Groundwater Level Measurement Summary Form whether the bottom of the monitoring well is hard or soft.
- Remove the cable from the monitoring well, and record the monitoring well depth measurement on the Groundwater Level Measurement Summary Form to the nearest 0.01 foot.
- Decontaminate the water-level meter in accordance with Farallon SOP EQ-01, Equipment Decontamination Procedures.
- If the presence of LNAPL is suspected or if site conditions are unknown, check for the presence of LNAPL by one of two methods:
  - Use of a bailer: Use a new 3-foot-long disposable bailer attached to a nylon rope. Slowly lower the bailer until the bottom of the bailer is approximately 2 feet below the water surface. Slowly retrieve the bailer, and measure the product thickness using a tape measure. Record the information on the Groundwater Level Measurement Summary Form. Dispose of the bailer and product or wastewater in accordance with Farallon SOP WM-01, Field Handling of Investigation-Derived Waste.
  - Use of an oil-water interface probe: Decontaminate the oil-water interface probe in accordance with Farallon SOP EQ-01, Equipment Decontamination Procedures. With the oil-water interface probe meter turned on to a medium level of sensitivity, slowly lower the probe into the monitoring well casing until it reaches the top of the LNAPL. The probe will have a steady beep when it reaches the interface of the LNAPL (when the electronic circuit is first completed). Stop lowering the probe, hold the graduated oil-water interface cable to the notch or mark on the northern side of the top of the monitoring well casing, and note the length measurement. Repeat this process to collect a second LNAPL measurement. If the two readings differ by more than 0.01 foot, repeat the measurements until the readings stabilize. Repeat the process until three consecutive stabilized readings have been measured. Record the depth to LNAPL measurement **only** in relation to the probe being lowered into the monitoring well, *not* as it is raised out of the monitoring well. If you cannot see the top of the monitoring well casing when the oil-water interface probe beeps, grasp the tape with your thumb and index finger exactly at the measuring point corresponding with the notch or mark at the top of the monitoring well casing. Slowly pull the cable out of the monitoring well and read the

measurement. Repeat until readings stabilize. Once the depth to LNAPL has been recorded, collect the water-level measurement as described above using the oil-water interface probe. Once the depth to LNAPL and the depth to the groundwater table have been determined, subtract the depth to LNAPL from the depth to the groundwater table to determine LNAPL thickness.

- Close the monitoring well as appropriate based on monitoring well-head construction. Record any concerns about monitoring well integrity on the Groundwater Level Measurement Summary Form and on the Field Report form.

## DOCUMENTATION

Document monitoring well water-level measurements on the Groundwater Level Measurement Summary Form. Document any additional information on the Field Report form.

## REFERENCE

U.S. Environmental Protection Agency. 1992. *RCRA Ground-Water Monitoring: Draft Technical Guidance.* Office of Solid Waste. November.

# STANDARD OPERATING PROCEDURE GW-04

# LOW-FLOW GROUNDWATER SAMPLING PROCEDURES

## PURPOSE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide field personnel with the methodology for collecting and documenting groundwater samples from monitoring wells using U.S. Environmental Protection Agency (EPA) low-flow groundwater sampling procedures (EPA 1996, 2017) for chemical analysis to ensure consistent and representative sampling. The step-by-step guidelines provided in this SOP are to be followed by the field crew conducting groundwater sampling.

## EQUIPMENT AND SUPPLIES/REAGENTS

The following equipment is necessary to properly purge and sample a monitoring well:

- Monitoring well key, hand drill, socket set, padlock key, or other monitoring well-access equipment.
- Electronic water-level meter long enough to reach the bottom of the monitoring well, calibrated to 0.01 foot. Alternatively, to measure for light nonaqueous-phase liquid thickness in addition to groundwater, use an oil-water interface probe.
- Monitoring well purging and sampling equipment:
  - Submersible pump (bladder or Grundfos): the pump, control box, and power source (typically a portable generator or a 12-volt battery); or
  - Peristaltic pump: the pump with pump head, silicone tubing, tubing connectors (as needed), and power source (typically a 12-volt battery).
- Sample tubing of project- and site-specific type and length.
- Bailer, if a pump is not used, or if light nonaqueous-phase liquid requires removal.
- Sufficient number of 55-gallon drums, including lids, gaskets, and fasteners, to contain all purge water, unless other water-handling arrangements have been made.
- Flow-through water-quality meter(s) to measure temperature, pH, specific conductivity, dissolved oxygen, oxidation-reduction potential (ORP), and turbidity.
- Air-space monitoring equipment if required (photoionization detector or multi-gas meter).
- Decontamination equipment and supplies (e.g., buckets, scrub brushes, deionized or distilled water, potable water, Liquinox detergent).
- Materials necessary to provide required documentation, (e.g., sample labels, Field Report forms, Low-Flow Well Purging and Sampling Data form, Chain of Custody form, Waste Inventory Tracking Sheet).

- Sample containers with the chemical preservatives appropriate for the samples, as described in project-specific plans, or as required by the analytical laboratory at a minimum.
- Personal protective equipment as described in the site-specific Health and Safety Plan (HASP).
- Sampling-support equipment (e.g., sample coolers, ice, bubble wrap, clear tape, duct tape, resealable plastic bags, garbage bags, paper towels, distilled water, nitrile gloves, shipping supplies).
- U.S. Department of Transportation-approved drum(s) for purge water, unless other water-handling arrangements have been made. Separate drums are needed for liquid and solid wastes (Refer to Farallon SOP WM-01, Field Handling of Investigation-Derived Waste). Liquid wastes should not be added to drums containing solid wastes.

## DECONTAMINATION

Before arrival at the site, upon relocation at the site, and upon demobilization from the site, decontaminate reusable equipment that will come into contact with the monitoring well(s) and/or be used to acquire samples, in accordance with Farallon SOP EQ-01, Equipment Decontamination Procedures.

## PROCEDURES FOR LOW-FLOW GROUNDWATER SAMPLING

Low-flow groundwater sampling procedures have been developed for monitoring wells with a dedicated pump (dedicated monitoring wells) and for monitoring wells without a dedicated pump (non-dedicated monitoring wells). Setup, purging, sample collection, and post-sampling procedures for dedicated and non-dedicated monitoring wells are presented below.

### Setup

Setup procedures differ slightly for dedicated versus non-dedicated monitoring wells. Follow the instructions below for the monitoring wells as indicated:

- Calibrate the water-quality meter for the field parameters specified in the project-specific plans. At a minimum, collect temperature, pH, and specific conductivity during purging and prior to sampling. Record on the Field Report form the equipment calibration and maintenance performed. Decontaminate the water-quality meter between monitoring wells by rinsing with distilled or deionized water. Manage the rinsate water used in collecting these measurements in the same manner as for purge water, as defined in project-specific plans, and in accordance with Farallon SOP WM-01, Field Handling of Investigation-Derived Waste.
- Don appropriate personal protective equipment as described in the site-specific HASP, including nitrile gloves for activities that might involve contact with groundwater or equipment. Change gloves between each monitoring well at a minimum, or when

contaminants could be introduced into a monitoring well or onto decontaminated equipment.

- Brush away soil and/or vegetation, and pump standing water away from the monitoring well opening. If necessary, place a plastic drop cloth around the monitoring well-head to prevent sampling equipment from contacting the ground surface.
- Inspect the condition of the monitoring well (e.g., locked monitoring well cap, tightness of monitoring well cap, well-marked measuring point on casing, disturbance of surface casing, straightness of monitoring well casing, condition of concrete pad). Indicate the monitoring well condition on the Low-Flow Well Purging and Sampling Data form.
- Open the monitoring well cap. If the site-specific HASP identifies organic compounds as potential contaminants of concern, screen the monitoring well headspace and the breathing zone headspace (if specified in the HASP) for organic vapors using the appropriate field monitoring instrument (e.g., photoionization detector, multi-gas meter).
- Measure and record the depth to water using a decontaminated water-level meter in accordance with Farallon SOP GW-03, Groundwater Level Measurements in Monitoring Wells.
- If light nonaqueous-phase liquid may be present (see site-specific plans), obtain a sample from the monitoring well using a bailer (if a dedicated pump is not in use), as specified in Farallon SOP GW-03, Groundwater Level Measurements in Monitoring Wells. Alternatively, measure free-floating product thickness using an oil-water interface probe.
- Calculate the monitoring well casing volume as follows:

  Monitoring well casing volume in gallons = $(\pi * r^2) * h$(7.48 gallons/cubic foot)

  Where:

  $r$ = radius of the inside of the monitoring well casing in feet

  $h$ = length of the water column in the monitoring well casing (i.e., the depth to the bottom of the monitoring well minus the depth to water, both measured from the mark at the top of the monitoring well casing), in feet

- **For monitoring wells with dedicated pumps and tubing**: Set up a flow-through cell in preparation for purging. Connect dedicated tubing from the monitoring well to the flow-through cell. Set tubing and/or pump to the correct water depth in accordance with the constituents being sampled for, as described in project-specific plans. **DO NOT IMMERSE water-quality probes or meters in purge water containing nonaqueous-phase liquids, which could damage the probes.** Turn the pump controller to its lowest setting, set the memory in the flow-through cell to record readings every 3 minutes, and turn on the pump. Begin purging slowly (i.e., less than 500 milliliters per minute [ml/min]) to prevent drawing down the water table.

- **For monitoring wells with non-dedicated pumps**: Connect dedicated silicon tubing to the peristaltic pump. Place the tubing intake at the midpoint of the screen, or at the depth pre-determined in the project-specific plans. If using a bladder pump, insert the bladder pump and attach the dedicated polyethylene tubing so the pump intake is at the approximate midpoint of the screened interval, or set the pump intake to the depth pre-determined in the project-specific plans.

## Purging Procedures

The purging instructions below are to be followed for dedicated and non-dedicated monitoring wells:

- Begin purging, and initiate water-quality testing for temperature, pH, specific conductivity, dissolved oxygen, ORP, and turbidity. Purge monitoring wells using a peristaltic or bladder pump, and dedicated polyethylene and silicon tubing. Record water-quality parameters every 3 minutes.
- Record water levels every 3 minutes, as possible. It is imperative that the water level not drop by more than 0.33 foot during the low-flow purging process. If the water level drops more than 0.33 foot during purging, reduce the flow rate on the pump. Recommended purge rates generally are less than 500 ml/min. Actual purge rates will vary based on aquifer material and monitoring well construction. If the water level continues to drop by more than 0.33 foot during the low-flow purging at a rate less than 100 ml/min, notify and consult with the Project Manager on how to proceed.
- Record flow rates every 3 minutes. Ensure that the flow rate does not exceed 500 ml/min during the low-flow purging process.

## Purging Requirements

Continue purging at a constant rate until the water-quality parameters have stabilized for three successive measurements according to the stability criteria provided in the table below. Before samples can be collected from each monitoring well, the groundwater must stabilize according to following criteria:

- Drawdown is no greater than 0.33 foot for low-flow sampling, and
- The water-quality parameters should stabilize according to the criteria specified below:

| Water-Quality Parameter | Stability Criterion |
|---|---|
| Turbidity (if required) | 10% for values greater than 5 NTU or three consecutive values < 5 NTU |
| Dissolved oxygen | 10% for values greater than 0.5 mg/l, or three consecutive values <0.5 mg/l |
| Specific conductivity | 3% |
| Oxidation-reduction potential | +/- 10 millivolts |
| pH | +/- 0.1 unit |
| Temperature | 3% |

Notes:

mg/l = milligrams per liter
NTU = nephelometric turbidity unit

Although under some circumstances, a monitoring well may not stabilize according to the above criteria, the monitoring well can still be sampled if the monitoring well does not meet stability criteria due to the instrument accuracy, or the water level drops below the minimum value using low-flow sampling procedures. For example, a fluctuation in ORP greater than 10 millivolts does not meet the stability criterion. However, because the accuracy range of the ORP instrument is ±20 millivolt, the stability criterion would be considered satisfied and within the range of instrument accuracy. Consult the manual for the instrument to determine the accuracy range.

Also, if the water level drops below the minimum value using low-flow sampling procedures (i.e., the pump intake, or the top of the screen if the aquifer is confined) during purging and one monitoring well volume of groundwater has been removed from the monitoring well, or the monitoring well runs dry during the purging procedure, sample the monitoring well as soon as the water level has recovered sufficiently to allow collection of the volume of groundwater necessary for all samples. Use the following equation to determine the minimum volume of groundwater to remove before sampling:

Minimum purge volume = 2*[500 milliliters + M*(length of tubing in feet)]

Where: M = volume (in milliliters) contained in a 1-foot length of tubing

The value of M is provided below for the inner diameters of tubing listed:

| Inner Diameter (inches) | M (milliliters) |
|---|---|
| 0.125 | 2.4 |
| 0.25 | 9.7 |
| 0.5 | 39 |

Record on the Field Report form and the Low-Flow Well Purging and Sampling Data form if any monitoring well did not meet the drawdown and stability criteria and explain the rationale for sampling the monitoring well at the time it was sampled. If stability criteria have not been achieved following completion of all entries in the Low-Flow Well Purging and Sampling Data form, notify and consult with the Project Manager whether to continue purging until stability criteria have been achieved or begin sample collection.

### Sample Collection

During low-flow sampling, do not stop pumping once the purging requirements have been met. Turn down the flow rate on the pump so the water flow is minimal, but maintain sufficient pressure in the system to prevent water from the tubing or flow-through cell from flowing back into the monitoring well. Disconnect the pump discharge hose from the flow-through cell, or cut the tubing just before the connection to the flow-through cell. It is imperative not to lower the water table or disturb the water column. Fill pre-cleaned laboratory-supplied sample containers directly from the pump discharge tube into the proper sample container, and fill to capacity. Place a bucket beneath the sampling tube to catch any unsampled water between filling the sample jars. When collecting groundwater samples for multiple analyses, collect the samples in the order listed below per the EPA (1992) groundwater sampling technical guidance:

- Volatile organic compounds (VOCs);
- Dissolved gases and total organic carbon;
- Semivolatile organic compounds;
- Metals and cyanide;
- Major water quality cations and anions;
- Radionuclides; and
- Dissolved (filtered) inorganics (if required).

When collecting samples for VOCs, adjust the flow rate as low as possible without introducing air bubbles into the system. When filling the VOC containers, hold the cap in hand to minimize contamination, and direct the flow from the pump discharge tubing down the side of the sample container to minimize aeration. Fill all VOC sample containers to the top, ensuring a positive meniscus when the cap is screwed down on the container. Tap the filled VOC container, and invert several times to ensure no air bubbles are present in the sample container. If an air bubble is present, the VOC sample must be recollected using a fresh VOC sample container. If sampling for other analytes, the flow rate may be increased.

If dissolved inorganics are required, attach a new disposable 0.45-micrometer filter cartridge to the discharge line. Collect filtered samples last. Pre-rinse the disposable filter cartridges by running a minimum of 0.25 gallon of groundwater through them (collecting the groundwater into a waste bucket) prior to collecting the samples directly into the sample container. Alternate field filtration methods may be specified in the project-specific plans. Remove the pump and/or tubing from the monitoring well.

### Post-Sampling

- Record the depth to water of well to determine whether the water level changed from the original reading.
- Close and lock the monitoring well or tap and record any monitoring well integrity concerns on the Field Report form and the Low-Flow Well Purging and Sampling Data form.
- Transfer purge, wash, and rinse water into a U.S. Department of Transportation-approved drum(s) and label. Separate drums are needed for liquid and solid wastes, in accordance with SOP WM-01, Field Handling of Investigation-Derived Waste. Do not add liquid wastes to drums containing solid wastes.

## PROCEDURES FOR RECONNAISSANCE GROUNDWATER SAMPLING

Collect reconnaissance groundwater samples from borings using direct-push or hollow-stem auger drilling methods and 0.75- or 2-inch-inside-diameter temporary monitoring well casing and 0.010-inch slotted screen. In some cases, alternate well casing diameters or screen slot sizes may be appropriate based on the drilling equipment or project-specific requirements. Follow the instructions below for reconnaissance groundwater sample collection:

- Withdraw the drill casing when the desired sampling depth has been reached, so the temporary monitoring well screen is exposed to water-bearing material.
- Insert disposable polyethylene tubing to the approximate midpoint of the temporary monitoring well screen. Attach the appropriate length of pre-cleaned disposable silicon tubing from the polyethylene tubing to connect with the peristaltic or bladder pump.
- Set up the peristaltic or bladder pump in preparation for purging. Turn the pump to its lowest setting and turn on the pump. Begin purging slowly to prevent drawing down the water table.
- Purge each temporary monitoring well point using a peristaltic or bladder pump until visual turbidity is as low as possible, or until the temporary monitoring well is purged dry of water.
- Purge a minimum of 1 to 2 liters before sample collection, if possible. If the temporary monitoring well is completely dewatered during purging, collect samples when sufficient recharge has occurred to allow filling of the sample containers.
- Slow the pumping rate to less than 500 ml/min to reduce the potential for volatilization of chemicals during sample collection.
- Collect the sample as described above.
- If insufficient groundwater is available to collect a sample using a peristaltic or bladder pump (i.e., the boring pumps dry or cannot maintain a sufficient flow of less than 100 ml/min) or if the depth to groundwater exceeds the maximum practicable limit for sampling using a peristaltic or bladder pump, use a disposable polyethylene bailer lowered

into the monitoring well screen to collect a groundwater sample from the screened interval, if possible.

## DOCUMENTATION

Document the monitoring well purging and sampling activities on the Low-Flow Well Purging and Sampling Data form and on the Field Report form. Track samples on a Chain of Custody form. Track waste generated during groundwater sampling on a Waste Inventory Tracking Sheet.

## REFERENCES

U.S. Environmental Protection Agency. 1992. *RCRA Ground-Water Monitoring: Draft Technical Guidance.* Office of Solid Waste. November.

———. 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures.* EPA/540/S-95/504. April.

———. 2017. *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.* EQASOP-GW4. September.

# STANDARD OPERATING PROCEDURE SL-01

# SOIL CORE SAMPLING

## PURPOSE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide field personnel with the methodology for collecting and documenting soil core samples using a hollow-stem-auger drill rig, a direct-push drill rig, and a sonic drill rig. All drilling operations will be conducted by a licensed drilling subcontractor in accordance with subcontractor SOPs. This SOP presents the procedures that will be performed by Farallon field staff once the soil core has been collected by the drilling subcontractor. The step-by-step guidelines provided in this SOP are to be followed by the field crew conducting subsurface soil sampling.

## EQUIPMENT AND SUPPLIES/REAGENTS

The following equipment is necessary to properly collect soil samples from borings:

- Personal protective equipment (PPE) as described in the site-specific Health and Safety Plan.
- Differential global positioning system, if required in project-specific plans. Discuss the methodology for recording the location of the sample point with the Project Manager before conducting the field work.
- Photoionization detector (PID) to monitor and record soil headspace readings.
- Applicable soil sampling equipment, including:
    - Stainless steel hand-auger.
    - Wooden or steel stakes to stabilize cores on table while sampling.
    - Folding table.
    - Utility knife.
    - Stainless steel spoons or scoops.
    - Six-mil plastic sheeting.
    - Resealable plastic bags.
    - Duct tape.
    - Aluminum foil.
    - Tape measure.
    - Five-gallon buckets, and scrub brushes.
    - Alconox phosphate-free cleanser.
    - Laboratory-provided certified pre-cleaned sample containers.

  - Soil sample plunger and syringes for sampling volatile organic compounds (VOCs) using U.S. Environmental Protection Agency (EPA) Method 5035A.
- Materials necessary to provide required documentation, including:
  - Camera.
  - White board and dry-erase markers, if specified in project-specific plan.
  - Sample labels.
  - Field Report forms.
  - Boring Log forms.
  - Chain of Custody forms.
  - Chain-of-custody seals for the sample cooler(s).
- U.S. Department of Transportation-approved drum(s) for decontamination wastewater and excess soil cuttings. Separate drums are needed for liquid and solid wastes (refer to Farallon SOP WM-01, Field Handling of Investigation-Derived Waste). Liquid wastes should not be added to drums containing solid wastes.
- Decontamination equipment as specified in Farallon SOP EQ-01, Equipment Decontamination Procedures.
- Sampling support equipment (e.g., sample coolers, ice, bubble wrap, clear packing tape, heavy resealable plastic bags, razor knives, garbage bags, paper towels, distilled water, nitrile gloves).

## DECONTAMINATION

Reusable equipment that will come into contact with soil boring samples or will be used to acquire soil samples is to be decontaminated before arrival at the site, between soil samples collected, upon relocation at the site, and upon demobilization from the site, in accordance with Farallon SOP EQ-01, Equipment Decontamination Procedures.

## PROCEDURES

*Prior to drilling, all underground utilities must be located, and cleared with an air-knife or other method approved by the Farallon Health and Safety Coordinator.*

Collect soil samples from areas known or suspected to have the lowest concentrations of constituents of concern first, with areas of higher concentrations of constituents of concern sampled last, unless the Project Manager indicates a different project-specific sampling protocol. The procedures listed below may be modified, with approval from the field team lead and the Project Manager. Any modifications must be identified in the project-specific sampling plans or, at a minimum, details must be noted on the Field Report form.

Soil core collection methods differ for hollow-stem-auger, direct-push, and sonic drilling techniques, each summarized below:

- Hollow-stem-auger: Collect soil core samples using a standard 18-inch-length (6-inch waste barrel) Dames & Moore split-spoon sampler with a 2.5-inch inner diameter that can be used with or without brass or stainless steel liners.
- Direct-push: Collect soil core samples using 5-foot macrocore samplers with acetate sample liners.
- Sonic: Collect soil core samples using a standard 6-inch-diameter stainless steel sampling rod. Use a 2.5-, 5.0-, or 10-foot polyethylene liner inside the sampling rod for soil sample collection.

Record the specific drilling and soil sampling equipment used on the Boring Log form and on the Field Report form.

## Setup

The instructions below are to be followed at each boring site:

- Don appropriate PPE as described in the site-specific Health and Safety Plan.
- Ensure that each borehole has been cleared to a minimum depth of 5 feet below ground surface using an air knife, per the Farallon health and safety policy.
- Set up a temporary sampling table adjacent to the drill rig to log and collect soil samples from the soil cores as they are recovered during drilling. During sunny conditions, consider using a portable canopy for protection from the sun. Lay plastic sheeting over the table to keep the surface clean and to prevent potential cross-contamination between borings and soil samples. Designate clean areas for decontaminated sampling equipment and laboratory-provided certified pre-cleaned soil sample containers.
- Set up 5-gallon buckets for decontaminating soil sampling equipment between samples. These decontamination buckets are separate from the buckets provided by the drillers for their split spoons and core barrels. (Refer to Farallon SOP EQ-01, Equipment Decontamination Procedures.)
- Calibrate the PID to monitor headspace for selected soil core samples in accordance with the equipment manual.

## Sample Collection and Processing

The instructions listed below are to be followed for collecting samples using lined and unlined split-spoon and tube samplers:

- Don a new pair of nitrile sampling gloves for each individual soil sample collected, and prior to decontaminating sampling equipment to avoid potential cross-contamination.

- Ensure that the drillers have properly decontaminated all drill shoes and caps prior to initiating drilling operations. Drill shoes and caps must be decontaminated between sampling intervals and stations in accordance with Farallon SOP EQ-01, Equipment Decontamination Procedures. Replace dirty or ineffective decontamination water as needed throughout the workday.
- Ensure that the drillers position the sampling rig over the sample station and remove any surface material or debris that would interfere with sampling. Note on the Field Report form any surface material removed.
- Note on the Field Report form and the Boring Log forms any difficulties encountered during drilling operations. Include the number of blow counts (if applicable) or any resistance encountered during drilling operations.
- Place the core tube, core liner, or split spoon on a new piece of aluminum foil on the sample logging/processing table. If necessary, use wood or metal stakes as shims to stabilize the tube, liner, or split spoon on the sample logging/processing table.
- If a core liner is used, split the liner open with a decontaminated utility knife, taking care not to penetrate the soil in the liner with the blade or knife.
- Briefly examine the soil sample visually for obvious signs of contamination, and take PID readings.
- Take care to:
    - **Not** collect soil in contact with the sidewalls of the sampler or liner.
    - **Always** use decontaminated stainless-steel spoons or scoops to handle the soil within a given sample interval.
    - **Always** don a new pair of nitrile gloves before processing each sample interval in each soil core to prevent cross-contamination in the soil core.
- When sampling for VOCs, collect them as soon as possible after opening the core tube, split spoon, or core liner. Use a decontaminated stainless steel spoon to collect the VOC samples with minimal disturbance to soil by placing a representative amount of soil from the length and depth of the desired sample interval directly into the laboratory-provided VOC sample container with no headspace, and seal it tightly. Follow the sample collection guidelines provided by the manufacturer or the analytical laboratory when using a plunger-type sampling device in accordance with EPA Method 5035A.
- Retain approximately 100 grams of the soil sample in a heavy resealable plastic bag or glass sample container, shake the sealed bag to volatilize the contaminants in the soil, and wait approximately 5 minutes before measuring for headspace analysis using the PID (Washington State Department of Ecology 2011). Insert the PID probe tip into a small opening in the top of the bag, and record the PID units on the Boring Log form. Reseal the bag after taking the headspace reading in case further assessment of the sample is needed. Do not puncture the resealable plastic bag to obtain headspace readings.

- If specified in the project-specific plans, photograph each section of the boring, including in the photograph notations on a white board documenting sample location identifier, date, orientation, depth, and site markers.
- Describe the soil samples in accordance with ASTM International Standard D-2488-00, *Standard Practice for Description and Identification of Soils*.
- Record on the Field Report form any deviations from the project-specified sampling procedures or from this SOP, or any obstacle encountered.
- Examine the remaining soil core sample for lithology using the Unified Soil Classification System, and record the lithology on the Boring Log form.
- Discard excess soil cuttings in a labeled waste drum or a soil bin in accordance with Farallon SOP WM-01, Field Handling of Investigation-Derived Waste. Do not add soil to a liquid waste drum.
- Backfill the borehole, as appropriate.
- Upon completion of sampling at a boring, measure the boring's location to an on-site permanent datum, collect the location using the differential global positioning system, or have the sample location surveyed by a licensed surveyor.
- Decontaminate the soil sampling equipment, and don a new pair of sampling gloves before collecting each new soil sample.

## DOCUMENTATION

Document the soil sampling activities on the Boring Log form, the Chain of Custody form, and the Field Report form.

## REFERENCE

American Society for Testing Materials. 1989. *Standard Method for Penetration Test and Split-Barrel Sampling of Soils.* Method D-1586-11.

U.S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operation Methods.* EPA Document No. 540-P-87-001. December 1.

Washington State Department of Ecology. 2011. *Guidance for Remediation of Petroleum Contaminated Sites.* Ecology Publication No. 10-09-057. Toxics Cleanup Program. September.

# STANDARD OPERATING PROCEDURE WM-01
# FIELD HANDLING OF INVESTIGATION-DERIVED WASTE

## PURPOSE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide field personnel with the methodology for containerizing, labeling, and tracking investigation-derived waste (IDW), and communicating information to the Project Manager. IDW may include soil cuttings, purge water, development water, and/or decontamination water. This SOP has been developed in compliance with Washington State Dangerous Waste Regulations (Chapter 173-303 of the Washington Administrative Code), Oregon Hazardous Waste Management Rules (Division 100 of Chapter 340 of the Oregon Administrative Record), Environmental Health Standards for the Management of Hazardous Waste (Division 4.5 of Title 22 of the California Code of Regulations), and the U.S. Environmental Protection Agency Resource Conservation and Recovery Act (Parts 239 through 282 of Title 40 of the Code of Federal Regulations).

## EQUIPMENT AND SUPPLIES/REAGENTS

The following equipment is necessary to properly containerize, label, and track IDW:

- U.S. Department of Transportation-approved drum(s) constructed of a material that does not react with the contaminants of concern for the project. Farallon typically uses lined open-top steel drums. Use a polyethylene drum for a material suspected to be corrosive.
- Labels appropriate to the characteristics of the IDW:
    - Non-Hazardous Waste Labels: For IDW known to be nonhazardous based on previous data and waste profiles.
    - Hazardous Waste or Washington State Dangerous Waste Labels: For IDW known to be hazardous/dangerous based on previous data and waste profiles.
    - On Hold Pending Analysis Labels: For waste not previously characterized, pending receipt of analytical results. On Hold Pending Analysis labels are temporary, and should be replaced with the applicable waste label once the waste has been characterized.
    - Another waste label as indicated by the Project Manager.
- Waste Inventory Tracking Sheet.
- Grease marking pencil or paint pen.
- Indelible ink pen.
- Crescent wrench, socket wrench, or other hand tool to seal the drum(s).
- Sampling supplies, if needed, including:
    - Stainless steel or plastic bowls and spoons for homogenizing soil and/or solids samples, depending on the analysis to be performed;

- Glass or stainless steel container for homogenizing liquid samples, depending on the analysis to be performed; and
- Stainless steel hand-auger or a glass tube, depending on the medium being sampled (i.e., soil/solids or liquid).

## PROCEDURES

Follow the instructions below to inspect, label, and inventory IDW drums, and to containerize IDW:

- Inspect new drums brought to the site to ensure that they do not have dents or corrosion, and are in good condition. Lined or coated drums are preferred.
- Inspect drums remaining at the site from previous project work. Notify the Project Manager if a drum is leaking, damaged, or improperly labeled.
- Place soil and solids into separate drums from those containing liquids such as purge water, development water, and decontamination water. Do not add liquid IDW to drums containing soil or solids. Do not fill drums containing liquid IDW above 85 percent capacity, particularly in areas known to reach freezing temperatures.
- Discuss with the Project Manager whether chlorinated solvents or other contaminants of concern detected in areas of the site would cause IDW from that area to be characterized as hazardous/dangerous waste. Hazardous/dangerous waste should be drummed separate from non-hazardous/dangerous waste to minimize the amount of hazardous/dangerous waste generated.
- Use a grease pencil/paint pen and indelible ink to clearly mark the lid and the label of each drum with a unique identifier such as a number or a letter. Verify that no two drums have the same identifier marked on the lid or label, including drums remaining from previous project work.
- Inventory each Farallon-generated drum and its contents on a Waste Inventory Tracking Sheet.
- Track any waste added to an existing drum on a Waste Inventory Tracking Sheet.
- Prior to demobilizing from the site, label each drum with a complete Non-Hazardous Waste, Hazardous Waste/Washington State Dangerous Waste, On Hold Pending Analysis, or other appropriate waste label. List the client’s name as the Shipper or Generator, and the accumulation start date as the date when waste was first placed into the drum, or when the waste was first designated as hazardous or dangerous based on analytical data. Consult the Project Manager with questions about the correct start date.

**Use care** when drumming, labeling, and tracking IDW; mistakes in the disposal of waste can result in serious legal and financial repercussions for Farallon and the client.

## DRUM SAMPLING

Sampling and analysis of wastes for hazardous/dangerous waste characterization purposes is to be conducted in accordance with U.S. Environmental Protection Agency Publication No. SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. Samples collected in California for hazardous waste characterization are to adhere to the requirements specified in California Code of Regulations Sections 66261.21 to 66261.24 of Title 22, Characteristics of Hazardous Waste. Discuss with the Project Manager the specific analyses to be performed prior to sample collection. The instructions below are to be followed for drum sampling, using composite sampling techniques to sample soil, solids, and liquid wastes:

- Collect soil/solids samples from various locations and depths in the drum using a hand auger or other decontaminated apparatus. Place all samples into a single decontaminated stainless steel bowl using decontaminated stainless steel tools, or into a plastic bowl using plastic spoons, depending on the analyses to be performed. Homogenize the samples in the bowl.
- Place samples of the homogenized soil/solids from the bowl into sample jars for analysis.
- Collect liquid samples from the drum using a glass sampling tube. Insert the tube to the base of the drum to fill the entire tube with liquid. Place the liquid into sample jars for analysis.

## DRUM STORAGE

Follow the instructions below for drum storage:

- Label and store the drums in an area approved by the client.
- Store hazardous/dangerous waste drums in a secured area.
- Place hazardous/dangerous waste drums to be stored outside on secondary containment and under cover.

## DOCUMENTATION

Document IDW drums on the Waste Inventory Tracking Sheet as described above. Provide the original Waste Inventory Tracking Sheet and the original field notes to the Project Manager. Provide a copy of the completed Waste Inventory Tracking Sheet to the Project Assistant for tracking.

## REFERENCE

U.S. Environmental Protection Agency. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. Publication No. SW-846. Third Edition, Final Updates I (1993), II (1995), IIA (1994), IIB (1995), III (1997), IIIA (1999), IIIB (2005), IV (2008), and V (2015).

# APPENDIX B
# FIELD SAMPLING FORMS

SAMPLING AND ANALYSIS PLAN
APPENDIX C OF THE REVISED CAPITAL INDUSTRIES PLANT 4
STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
Capital Industries, Inc.
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

FARALLON
CONSULTING

Washington
Issaquah | Bellingham | Seattle
Oregon
Portland | Bend | Baker City
California
Oakland | Sacramento | Irvine

# FIELD REPORT

**Page __ of ___**

**Date:** _____________ **Project #:** __________________________________ **Task #:**_______________

**Project:** _____________________________________ **Site Address:** _____________________________________

**Client:** ______________________________________ **Contractor:** ______________________________________

**Weather:** ____________________________________ **Temp:** ___________

**Equipment Used:** ____________________________________________________________________________

**Hours:** ________ _________ **Mileage:** _________ **Project Manager:** ________________________________

*Contractor* *Staff*

**Prepared By:** _________________________________ **Reviewed By:** ______________________________________

**Comments:**

# FIELD REPORT (continued)

Page __ of ___

**Project:** ______________________________ **Date:** ____________ **Project #:** _____________ **Task #:**_______

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FARALLON
CONSULTING

# Log of Boring:

Page __ of __

**Client:**
**Project:**
**Location:**
**Farallon PN:**
**Logged By:**

**Date/Time Started:**
**Date/Time Completed:**
**Equipment:**
**Drilling Company:**
**Drilling Foreman:**
**Drilling Method:**

**Sampler Type:**
**Drive Hammer (lbs.):**
**Depth of Water ATD (feet bgs):**
**Total Boring Depth (feet bgs):**
**Total Well Depth (feet bgs):**

| Depth (feet bgs) | Sample Interval | Lithologic Description | USCS | USGS Graphic | % Recovery | Blow Counts 8/8/8 | PID (ppm*) | Sample ID | Sample Analyzed | Boring/Well Construction Details |
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**Well Construction Information**

Monument Type:
Casing Diameter (inches):
Screen Slot Size (inches):
Screened Interval (ft bgs):

Filter Pack:
Surface Seal:
Annular Seal:

Ground Surface Elevation (ft):
Top of Casing Elevation (ft):
Boring Abandonment:
Surveyed Location: X: Y:

# SOIL SAMPLE DATA

PROJECT NAME:

PROJECT NO:

SHEET OF

PROJECT LOCATION:

PID MODEL & SERIAL NO:

CALIBRATION DATE/STANDARD:

HEADSPACE CONTAINER: ☐ 16 OZ GLASS ☐ 8 OZ GLASS ☐ 4 OZ GLASS ☐ ZIP-LOC

SAMPLE METHOD: ☐ SONIC ☐ HAND AUGER ☐ HOLLOW STEM ☐ SPLIT SPOON ☐ GEOPROBE ☐ BACKHOE BUCKET

EQUIP DECON: ☐ TAP WATER WASH ☐ DIST/DEION 1 RINSE ☐ ISOPROPANOL ☐ ANALYTE FREE FINAL RINSE

☐ ALCONOX WASH ☐ LIQUINOX WASH ☐ DIST/DEION 2 RINSE ☐ OTHER SOLVENT ☐ DIST/DEION FINAL RINSE ☐ AIR DRY

| LOCATION | DATE | SAMPLE NAME/ NUMBER OF CONTAINERS | DEPTH | TIME | STAINING | ODOR | PID | SHEEN | LITHOLOGIC DESCRIPTION<br>REMARKS |
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PREPARED BY:

# MONITORING WELL CONSTRUCTION DATA

WELL/BORING NO:

PROJECT NO:

PROJECT NAME:

PERMIT NO:

DATE:

SITE ADDRESS:

WELL SITE LOCATION PLAN:

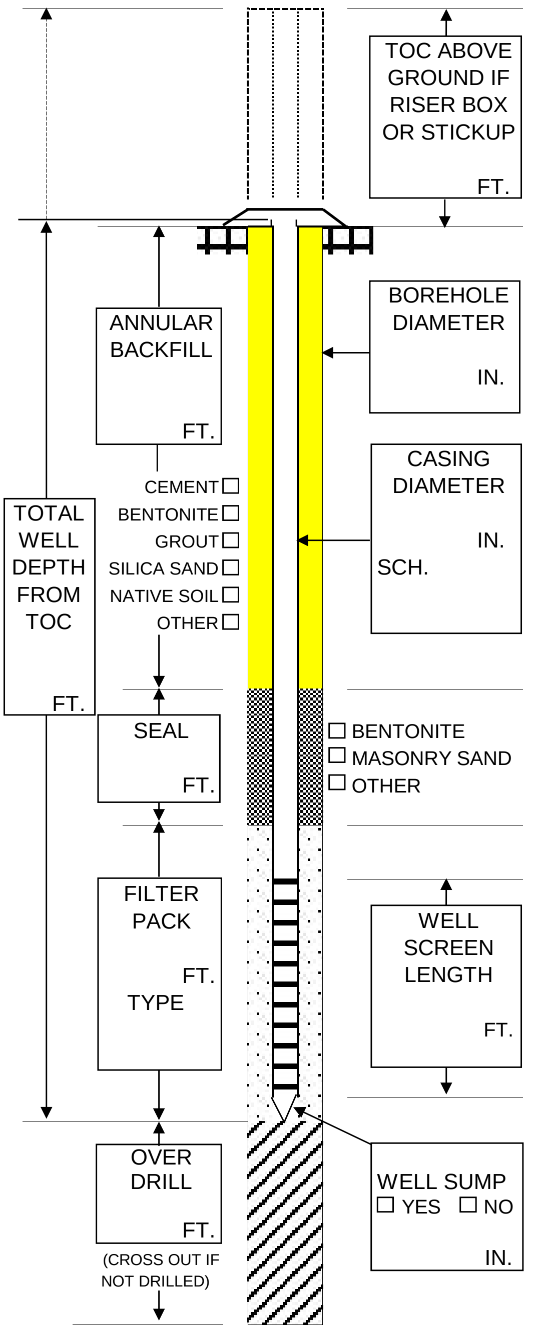
SEC: TWN: RGE: LAT: LONG:

DRILLING CO:

DRILL CREW:

WELL TYPE: ☐ SHALLOW ☐ SINGLE CASED ☐ MONITORING
☐ PERMANENT ☐ INTERMEDIATE ☐ DOUBLE CASED ☐ RECOVERY
☐ TEMPORARY ☐ DEEP ☐ OTHER ☐ OTHER

## WELL SCHEMATIC



## INSTALLATION DATA

DECON. ☐ STEAM CLEAN ☐ HIGH PRESSURE WASH
☐ SOAP WASH ☐ OTHER

CASING TYPE: ☐ PVC ☐ STAINLESS ☐ TEFLON ☐ OTHER
JOINTS: ☐ THREADED ☐ WELDED ☐ COUPLED
☐ SCREWED ☐ OTHER
PIT CASING: ☐ YES ☐ NO ☐ DESCRIBE

WELL SCREEN: ☐ PVC ☐ STAINLESS ☐ TEFLON ☐ OTHER
DIAMETER: ☐ 2" ☐ 4" ☐ 6" ☐ OTHER ______ IN
SLOT: ☐ 0.010 ☐ 0.020 ☐ OTHER ______ IN

DRILLING METHOD: ☐ SOLID STEM ☐ HOLLOW STEM ☐ MUD ROTARY
☐ AIR ROTARY ☐ DIRECT PUSH ☐ HAND AUGER
☐ OTHER
BIT SIZE: ☐ 2" ☐ 4" ☐ 6" ☐ 8" ☐ 12" ☐ OTHER ______ IN
DRILLING MUD: ☐ NONE ☐ WATER ☐ BENTONITE
☐ OTHER
CENTRALIZER: ☐ YES ☐ NO

COMPLETION: ☐ FLUSH MOUNT ☐ STICKUP ☐ RISER BOX
LOCK TYPE: ☐ DOLPHIN ☐ MASTER KEY NO.
☐ OTHER
PAD: ☐ 2'X2' ☐ 4'X4' ☐ OTHER

CUTTINGS: ☐ DRUMMED NUMBER OF DRUMS
☐ SPREAD ☐ OTHER

DEVELOPMENT METHOD: ☐ NONE ☐ BAILING ☐ PUMPING ☐ AIR LIFT
☐ SURGE & BLOCK ☐ OTHER
TIME: ☐ 10 MIN ☐ 20 MIN ☐ OTHER ______ MIN
AMOUNT: ☐ 5 GAL ☐ 10 GAL ☐ OTHER ______ GAL
WATER BEFORE: ☐ SILTY ☐ TURBID ☐ OPAQUE ☐ CLEAR
WATER AFTER: ☐ SILTY ☐ TURBID ☐ OPAQUE ☐ CLEAR
EVIDENT ODOR: ☐ YES ☐ NO TYPE

DEVELOPMENT WATER: ☐ DRUMMED NUMBER OF DRUMS
☐ SPREAD ☐ TREATED ☐ POTW ☐ OTHER

WATER LEVEL: INITIAL ______ FT ☐ BTOC ☐ BLS

DATE: ______ ______ FT BELOW TOC

DATE: ______ ______ FT BELOW TOC

NOTES: (DESCRIBE ALL NON-STANDARD METHODS & MATERIALS)

PREPARED BY:

FARALLON
CONSULTING

# Groundwater Level Measurement Summary Form

**Date:** **Project Name:**

**Project Number:** **Task:** **Project Location:**

**Equipment Used:** **Project Manager:**

| Well Number | Time | Depth to NAPL (feet) | Depth to Water (feet) | NAPL Thickness (feet) | Total Well Depth (feet) | Comments |
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**Prepared By:**

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Page ________ of ________

# LOW-FLOW WELL PURGING AND SAMPLING DATA

WELL NO:

DATE: PROJECT NAME: PROJECT NO:

WEATHER CONDITIONS:

WELL DIAMETER (IN.) ☐ 1 ☐ 2 ☐ 4 ☐ 6 ☐ OTHER ____________

SAMPLE TYPE: ☐ GROUNDWATER ☐ WASTEWATER ☐ SURFACE WATER ☐ OTHER

WELL DEPTH (TOC) FT. DEPTH TO WATER BEFORE PURGING (TOC) FT.

LENGTH OF WATER FT. CALCULATED ONE WELL VOLUME[1]: __ GAL.

DEPTH OF SAMPLE POINT FT. ESTIMATED VOLUME PURGED GAL.

EQUIP. DECON. ☐ ALCONOX WASH ☐ LIQUINOX WASH ☐ DIST/DEION 1 RINSE ☐ DIST/DEION 2 RINSE ☐ OTHER

CONTAINER PRESERVATION: ☐ LAB PRESERVED ☐ FIELD PRESERVED

WATER ANALYZER: PUMP TYPE: TUBING:

| ACTUAL TIME (min) | FLOW RATE (ml/min) | DEPTH TO WATER (feet) | TEMP ☐ °F ☐ °C 3% | SPECIFIC CONDUCT. (mS/cm) 3% | pH +/- 0.1 | DISS. OXYGEN (mg/l) <0.5 mg/L or 10% for > 0.5 mg/L | TURBIDITY (NTU) <5 NTU or +/- 10% for > 5 NTU | ORP (mV) +/- 10 mV | REMARKS (EVIDENT ODOR, COLOR, PID) |
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DEPTH TO WATER AFTER PURGING (TOC) FT. SAMPLE FILTERED ☐ YES ☐ NO SIZE ______

NOTES:

SAMPLE TIME: ID# __ __

DUPLICATE ☐ TIME: ID#:

EQUIP. BLANK: ☐ TIME: ID#:

PREPARED BY:

---

[1] A 1 FOOT LENGTH OF WATER = 0.05 GAL IN 1" DIA. PIPE 0.17 GAL IN 2" DIA PIPE 0.65 GAL IN 4" DIA PIPE 1.5 GAL IN 6" DIA PIPE

# WASTE INVENTORY TRACKING SHEET

**Project Number:** ______________________ **Page:** ________ **of** ________

**Project Name:** ______________________ **Generation Date:** ______________________

**Project Address:** ______________________ **Prepared By:** ______________________

**Field Work Description:** ______________________ **Date Waste Removed:** ______________________

**Project Manager:** ______________________ **Waste Transporter:** ______________________

**Waste Disposal Location:**

| Unique Container ID | Container Size | % Capacity Used | Contents (Soil/GW/Decon Water)/ Origin (Boring or Well ID) | Date(s) Accumulated | Labeling (Contents Under Test/ Haz/Non-Haz/Other-Specify) | Sampled (Y/N) | Comments |
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**NOTES: Contents should be specified and include identification of well/boring, media, source, depth of soil (if applicable), and any other helpful information.**

**Container ID should be unique when compared against other nearby containers. Special waste labels may include flammable, corrosive, dangerous when wet, and/or oxidizer.**

Location of Drums (sketch or describe):

FARALLON
CONSULTING

**OnSite Environmental Inc.**

14648 NE 95th Street
Redmond, WA 98052
(425) 883-3881

Client ______________________________

Project ______________________________

Sample ID ______________________________

Date ______________ Time ______________

Analysis ______________ Preservative ______________

# THIS CONTAINER ON HOLD PENDING ANALYSIS

**CONTENTS** ______________________

______________________

______________________

**ORIGIN OF MATERIALS** ______________________

**ADDRESS** ______________________

**CONTACT** ______________________

**DO NOT TAMPER WITH CONTAINER**
**AUTHORIZED PERSONNEL ONLY**

BRADY® BRADYID.COM

**OnSite Environmental Inc.**
Analytical Laboratory Testing Services
14648 NE 95th Street • Redmond, WA 98052
Phone: (425) 883-3881 • www.onsite-env.com

# Chain of Custody

Page ______ of ______

**Laboratory Number:**

Company:

Project Number:

Project Name:

Project Manager:

Sampled by:

**Turnaround Request (in working days)**

(Check One)

☐ Same Day ☐ 1 Day
☐ 2 Days ☐ 3 Days
☐ Standard (7 Days) (TPH analysis 5 Days)
☐ ________________ (other)

| Lab ID | Sample Identification | Date Sampled | Time Sampled | Matrix | Number of Containers | NWTPH-HCID | NWTPH-Gx/BTEX | NWTPH-Gx | NWTPH-Dx | Volatiles 8260C | Halogenated Volatiles 8260C | Semivolatiles 8270D/SIM (with low-level PAHs) | PAHs 8270D/SIM (low-level) | PCBs 8082A | Organochlorine Pesticides 8081B | Organophosphorus Pesticides 8270D/SIM | Chlorinated Acid Herbicides 8151A | Total RCRA Metals | Total MTCA Metals | TCLP Metals | HEM (oil and grease) 1664A | | | | | | % Moisture |
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| | Signature | Company | Date | Time | Comments/Special Instructions |
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| Relinquished | | | | | |
| Received | | | | | |
| Relinquished | | | | | |
| Received | | | | | |
| Relinquished | | | | | |
| Received | | | | | |
| Reviewed/Date | | Reviewed/Date | | | Chromatograms with final report ☐ |

Data Package: Standard ☐ Level III ☐ Level IV ☐ Electronic Data Deliverables (EDDs) ☐ ________________

CARUS®

# CHAIN OF CUSTODY RECORD

ITEMS LISTED IN RED MUST BE COMPLETED BY CLIENT

**CLIENT**

**PROJECT NAME**

**SITE LOCATION (City and State)**

**P.O. NUMBER**

**ANALYSIS REQUESTED**

**(FOR INTERNAL USE ONLY)**

TECH # ______________________

LOGGED BY: ______________________

Customer Support Rep:______________

Report Issued:____________________

Taxable:_________________________

**ADDRESS**

**PHONE NUMBER**

**TURN AROUND TIME**
(please circle one):
(Rush is subject to Carus approval)

NORMAL

RUSH

**DATE SHIPPED**

**CITY**
**STATE**
**ZIP**

**SAMPLER**
**(PLEASE PRINT)**

**RemOx® ISCO Reagent**

☐ $KMnO_4$

☐ $NaMnO_4$

☐ EITHER

**PROJECT MANAGER**

**SAMPLER'S SIGNATURE**

| SAMPLE DESCRIPTION | DATE COLLECTED | TIME COLLECTED | SAMPLE TYPE<br>SOIL | <br>GW | SOIL TYPE | # OF CONT | PNOD Soil Demand ASTM D7262-10 | | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |
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**SEND RESULTS TO (please list email address):**

**ADDITIONAL COMMENTS:**

| | | | | |
|---|---|---|---|---|
| RELINQUISHED BY: (SIGNATURE) | DATE<br>TIME | RECEIVED BY: (SIGNATURE) | DATE<br>TIME | COMMENTS: (FOR INTERNAL USE ONLY)<br>______________________<br>______________________ |
| RELINQUISHED BY: (SIGNATURE) | DATE<br>TIME | RECEIVED AT LAB BY: (SIGNATURE) | DATE<br>TIME | SAMPLE(S) RECEIVED ON ICE Y OR N<br>BOTTLES RECEIVED IN GOOD CONDITION Y OR N<br>BOTTLES FILLED WITH ADEQUATE VOLUME Y OR N<br>SAMPLES RECEIVED WITHIN HOLD TIME(S) Y OR N |

**SEND SAMPLES TO:**
Carus Corporation
1500 8th Street
Attn: Building 45
LaSalle, IL 61301

# APPENDIX C
# CARUS CORPORATION PERMANGANATE NATURAL OXIDANT DEMAND PROCEDURE BRIEF

SAMPLING AND ANALYSIS PLAN
APPENDIX C OF THE REVISED CAPITAL INDUSTRIES PLANT 4
STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
Capital Industries, Inc.
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

# Permanganate Natural Oxidant Demand (PNOD) Procedure and Non-Regulated Soil Submittal Procedure

RemOx® ISCO Reagent

TECHNICAL BRIEF

## PROCEDURE

Carus Corporation follows ASTM Method D7262-10, Test Method A, for permanganate natural oxidant demand (PNOD) analysis. A brief summary of D7262-10 Test Method A follows:

For each soil sample, 600 g of soil are baked at 105°C. The soils are dosed in triplicate at one initial potassium permanganate ($KMnO_4$) level of 100 ml of 20g/L $KMnO_4$ to 50 g of soil for an initial dose of 40 g $KMnO_4$/kg dry soil. The reactor vials are gently inverted. Following 48 hours of reaction time, the liquid portion of the treated sample is analyzed for permanganate residual following method 4500-$KMnO_4$ Potassium Permanganate in Standard Methods for the Examination of Water and Wastewater.

To order a complete copy of the ASTM method, visit http://www.astm.org.

## NON-REGULATED SOIL SUBMITTAL PROCEDURE

Note: This procedure is for soils from areas of the United States for which movement is not restricted under the U.S. Department of Agriculture (USDA).

For each sample location at a remediation site, collect at least 600 grams of soil sample. Two completely filled 250-mL wide mouth glass jars (free of large rocks) with PTFE lined screw caps will provide a sufficient quantity. The ASTM D7262-10 method for PNOD specifies that at least 600 grams soil/aquifer solids be available at the start of testing. Groundwater is not collected for this method.

Fill the containers completely and pack the soil as tightly as possible to eliminate as much entrapped air as possible.

Record the following information on the labels of the sample containers:

Date and time of sampling
Location of the sampling
Initials of the person collecting the sample

Enclose the bottles in bubble wrap or other acceptable packing material to prevent the glass bottles from breaking in transit. Place the samples in a cooler with ice if needed to maintain proper temperature. ASTM D7262-10 specifies the holding time of samples as up to 28 days if held at 4°C.

The Carus laboratory is closed on weekends and holidays. Samples should be shipped between Monday and Thursday to the address below specify overnight delivery. As part of the Responsible Care® 14001 Plant Security requirements, the following information must be on the outside of the shipping container:

Carus Corporation
Attention: Dylan Kemmerer
1500 Eighth Street
Bldg 45- Customer Service Lab
LaSalle, IL 61301

Also include the name and address of the originator, the contact person and a phone number on the shipping container.

Note: The Carus receiving department will not accept samples without the identifications above.

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# APPENDIX D
# CARUS CORPORATION RemOx DESK REFERENCE

SAMPLING AND ANALYSIS PLAN
APPENDIX C OF THE REVISED CAPITAL INDUSTRIES PLANT 4
STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
Capital Industries, Inc.
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

# CARUS
## REMEDIATION

RemOx® Desk Reference:

RemOx® ISCO Reagent

TECHNICAL BRIEF

## RemOx® S ISCO Reagent ($KMnO_4$) Calculations

### Calculation for Mixing RemOx S Concentrations in One Gallon of Water

| RemOx S % | Relative Density* | Pounds of RemOx S |
|---|---|---|
| 1 | 1.007 | 1/12 |
| 2 | 1.014 | 1/6 |
| 3 | 1.020 | 1/4 |
| 4** | 1.027 | 1/3 |

* Estimated

** Achieving a >4% concentration of RemOx S is difficult and is not recommended unless using heated water.

### Alternative Calculation for Mixing RemOx S Solutions

| | |
|---|---|
| Calculation: | Final volume of RemOx S in gallons x desired RemOx S % x weight of 1 gallon $H_2O$ or 8.345 lbs. = pounds of RemOx S |
| Example: | Need 2,000 gallons of a 2.5% solution<br>2,000 x 0.025 x 8.345 = 417.25 lbs. RemOx S |

## RemOx® L ISCO Reagent ($NaMnO_4$) Calculations

### Diluting RemOx L

| | |
|---|---|
| Calculation: | Total gallons x desired concentration % x relative density of desired concentration in g/mL x weight of 1 gallon of water = pounds of 100% $NaMnO_4$ |
| Example: | 2,000 gallons x 0.1 x 1.08 x 8.345 = 1,802.5 lb 100% $NaMnO_4$ or 4,506.3 pounds 40% $NaMnO_4$<br>Convert from 100% $NaMnO_4$ to 40% $NaMnO_4$ divide by 0.4 |

### To Convert RemOx L from Pounds to Gallons Divide Pounds by Weight of 1 Gallon of RemOx L

| RemOx L % | Relative Density* | Weight of one Gallon of RemOx L |
|---|---|---|
| 40 | 1.37 | 11.43 |
| 20 | 1.18 | 9.67 |
| 15 | 1.12 | 9.34 |
| 10 | 1.08 | 9.09 |
| 5 | 1.04 | 8.67 |

* Estimated

Note: Calculators are available to assist with diluting RemOx S or RemOx L. Contact Carus Remediation Technologies.

## General RemOx Calculations

### Convert RemOx S to RemOx L

| | |
|---|---|
| Calculation: | Divide RemOx S by 0.4 and multiply by 0.898 |
| Example: | What is the equivalent amount of RemOx L for 5,000 pounds of RemOx S?<br>(5,000/0.4) x 0.898 = 11,225 pounds RemOx L |

### Convert RemOx L to RemOx S

| | |
|---|---|
| Calculation: | Divide RemOx L by 0.898 and multiply by 0.4 |
| Example: | What is the equivalent amount of RemOx S for 5,000 pounds of RemOx L?<br>(11,225 x 0.4) / 0.898 = 5,000 pounds RemOx S |

CORPORATE HEADQUARTERS | 315 Fifth Street, Peru IL 61354 | Tel + 1.815.223.1500 / 1-800-435-6856 | Fax + 1.815.224.6697 | Web: www.caruscorporation.com | E-Mail: salesmkt@caruscorporation.com

CARUS EUROPE | Parque Empresarial de ASIPO | C/Secundino Roces 3, Planta 1, Oficina 13-14 | 33428 Cayes, Llanera Spain | Tel +34.985.78.55.13 / Fax +34.985.78.55.10

Form# RX 1698

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# CARUS
## REMEDIATION

RemOx® Desk Reference:

RemOx® ISCO Reagent

## TECHNICAL BRIEF

## Common Contaminants of Cencern Solubility and RemOx Effectiveness

| COC | Solubility mg/L @ 68-77°F | Oxidized by Permanganate |
|---|---|---|
| Vinyl chloride | 1,100 | Yes |
| 1,1 Dichloroethene<br>1,2 tDichloroethene | 400<br>6,300 | Yes |
| Trichloroethene | 1,100 | Yes |
| Tetracholoroethene | 150 | Yes |
| Carbon tetrachloride | 785 | No |
| Methylene chloride | 13,000 | No |
| Benzene | 1,800 | No |
| Toluene | 520 | Yes |
| Ethylbenzene | 187 | Yes |
| Xylenes | 152-157 | Yes |
| Chlorobenzene | 502 | No |
| Dichlorobenzenes | 42-156 | No |
| Trichlorobenzenes | 2.4-52 | No |

| COC | Solubility mg/L @ 68-77°F | Oxidized by Permanganate |
|---|---|---|
| Naphthalene | 25 | Yes |
| Phenanthrene | 0.9 | Yes |
| Pyrene | 0.11-0.18 | Yes |
| Styrene | 300 | Yes |
| 1,4-dioxane | Miscible | Yes |
| Pentachlorophenol | 10-20 | Yes |
| MTBE | 4,800 | Partially |
| Tert-butyl alcohol | Miscible | No |
| GRO | Varied | Partially |
| DRO | Varied | Partially |
| RDX & HMX | 7.6 & 6.6* | Yes |
| TNT &DNT | 115 & 180 | No |
| PCBs | 0.003 -906* | No |

Solubility Reference: Montgomery, John H. (2007). Groundwater Chemicals Desk Reference (4th ed.). Boca Raton, Florida: CRC Press, LLC.

*References available upon request

## Permanganate Color Chart in mg/L

CARUS CORPORATION

ONE COMPANY, ENDLESS SOLUTIONS

CORPORATE HEADQUARTERS | 315 Fifth Street, Peru IL 61354 | Tel +1.815.223.1500 / 1-800-435-6856 | Fax +1.815.224.6697 | Web: www.caruscorporation.com | E-mail: salesmkt@caruscorporation.com

CARUS EUROPE | Calle Rosal 4, 1-B | Oviedo, Spain 33009 | Tel +34.985.785.513 / Fax +34.985.785.510

Rev. 08/17
Form# RX 1698

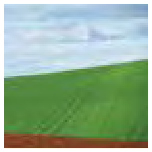
CARUS®

# APPENDIX E
# CARUS CORPORATION RemOx ISCO REAGENT RESIDUAL DETERMINATION BRIEF

SAMPLING AND ANALYSIS PLAN
APPENDIX C OF THE REVISED CAPITAL INDUSTRIES PLANT 4
STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
Capital Industries, Inc.
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

**CARUS**
**REMEDIATION**


# RemOx® ISCO Reagent Residual Determination Using the Hach DR 890

## TECHNICAL BRIEF

## OBJECTIVE

This method can be used to determine the residual permanganate in water using standard spectrophotometric methods.

## NOTE

If the instrument is being used for the first time, a calibration curve needs to be stored in the instrument. The absorbance is measured at 520 nm. A minimum of three standards should be used to generate this curve. (See instructions in the DR 890 instruction manual).

## PROCEDURE

1. Obtain a water sample of unknown permanganate concentration and filter through a 0.45 um oxidant-resistant syringe filter (recommended examples are Whatman 0.45 um syringe filters or Millipore Millex GV syringe filters). This is to remove any turbidity and $MnO_2$ that may be present.

2. The sample may need to be diluted at this time. The acceptable range for reading residual permanganate on the DR 890 is approximately 1-50 mg/L. The sample should be diluted with deionized water to read within this range.

3. Enter program number 102 for the stored program on the instrument.

4. Zero the colorimeter using either deionized water or filtered, untreated groundwater. Fill the vial to the 25 mL mark and face the diamond shape on the sample cell towards the keypad. Note: Be sure to wipe the vial so it is clean, free of streaks, and dry. Place the light shield over the sample cell and press zero on the instrument.

5. Fill a second vial to the 25 mL mark with filtered groundwater containing an unknown concentration of permanganate. Note: Be sure to wipe the vial so it is clean, free of streaks, and dry. Place the light shield over the sample cell and press read on the instrument. The program will give the result in mg/L as either $KMnO_4$ or $NaMnO_4$. All Carus rental units read the results as $KMnO_4$. If a dilution was used, multiply the colorimeter reading by the dilution factor.

## CALCULATION

If analyzing for RemOx® L ISCO reagent (sodium permanganate) use the following equation to convert: mg/L $KMnO_4$ X 0.895 = mg/L $NaMnO_4$

## RETURN INFORMATION

Please be sure all vials are empty and clean before shipping the kit back to Carus. No liquids should be shipped. Please send colorimeter back to the address listed below and insure shipment for $1,500. Thank you!

Carus Corporation
Attention: Dylan Kemmerer- Bldg 45
1500 8th Street
LaSalle, IL 61301

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form RX 1639

# APPENDIX D
# QUALITY ASSURANCE PROJECT PLAN

REVISED CAPITAL INDUSTRIES PLANT 4 STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

# QUALITY ASSURANCE PROJECT PLAN
# APPENDIX D OF THE REVISED CAPITAL INDUSTRIES PLANT 4 STAGE 1 FIELD IMPLEMENTATION WORK PLAN

**West of 4th Group Site**
**Capital Industries, Inc.**
**5801 3rd Avenue South**
**Seattle, Washington**

**Submitted by:**
**Farallon Consulting, L.L.C.**
**975 5th Avenue Northwest**
**Issaquah, Washington 98027**

**Farallon PN: 457-008**

**For:**
**West of 4th Avenue Group**
**Site Unit 2 Joint Deliverable**
**Capital Industries, Inc.**
**Blaser Die Casting Co.**
**Stericycle**
**Seattle, Washington**

May 10, 2018

Prepared by:

Jennifer L. Moore
Senior Scientist

Reviewed by:

Jeffrey Kaspar, L.G., L.H.G.
Principal Geologist

# TABLE OF CONTENTS

## FIGURES

## TABLES

# 1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared by Farallon Consulting, L.L.C. (Farallon) on behalf of Art Brass Plating, Inc.; Blaser Die Casting Co.; Capital Industries, Inc. (CI); and Burlington Environmental, LLC[1] (collectively referred to herein as the West of 4th Group). The QAPP has been prepared in accordance with the requirements of Agreed Order No. DE 10402 entered into by the West of 4th Group and the Washington State Department of Ecology (Ecology) in April 2014 (Agreed Order); the First Amendment to Agreed Order No. DE 10402 dated November 20, 2017; and the Washington State Model Toxics Control Act Cleanup Regulation as established in Chapter 173-340 of the Washington Administrative Code (WAC 173-340).

The West of 4th Group Site consists of Site Unit 1 and Site Unit 2 (herein referred to collectively as the Site) (Figure 1). The Art Brass Plating, Inc. property is located at Site Unit 1. The CI and Blaser Die Casting Co. properties are located at Site Unit 2. This QAPP provides specific requirements for quality assurance and quality control (QA/QC) procedures for the performance monitoring associated with Stage 1 of the interim action presented in the *Revised Capital Industries Plant 4 Stage 1 Field Implementation Work Plan, West of 4th Group Site, Capital Industries, Inc., 5801 3rd Avenue South, Seattle, Washington* dated May 10, 2018 prepared by Farallon (Work Plan) that will be completed at CI Plant 4, depicted on Figure 2.

As stated in the Ecology document *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies* dated July 2004, revised December 2016 (Ecology Publication No. 04-03-030), the purpose of the QAPP is to:

- Assist the Project Manager and the project team in focusing on factors affecting data quality during the planning stage of the project;
- Facilitate communication among field, laboratory, and management staff as the project progresses;

---

[1] Burlington Environmental, LLC, is a wholly owned subsidiary of PSC Environmental Services, LLC, which is a wholly owned subsidiary of Stericycle Environmental Solutions, Inc.

- Document the planning, implementation, and assessment procedures for QA/QC activities for the performance monitoring associated with the interim action;
- Ensure that the data quality objectives (DQOs) are achieved; and
- Provide a record of the project to facilitate final report preparation.

Both qualitative and quantitative DQOs were previously established for the remedial investigation (RI) conducted at the CI property to define the appropriate types of data, and to specify the tolerable levels of potential decision errors that will be used as a basis for establishing the quality and quantity of data needed to support the RI. This QAPP is an extension of the RI QAPP[2] specific to Stage 1 of the planned interim action, which consists of in-situ chemical oxidation of tetrachloroethene, trichloroethene, and associated degradation compounds, collectively known as the constituents of concern (COCs), using potassium permanganate and associated performance monitoring. This QAPP details both the qualitative and quantitative aspects of sample collection and analysis, including analytical methods, QA/QC procedures, and data quality reviews, to ensure that the DQOs are achieved.

## 1.1 PROJECT OBJECTIVE

The interim action objectives are tied to the remedial action objectives for the Site as described in the *West of Fourth Site Unit 2 Feasibility Study, Seattle, Washington* dated August 11, 2016, prepared by the West of Fourth Group and Pacific Groundwater Group for the West of Fourth Joint Agreed Order, Art Brass Plating, Blaser Die Casting, CI, and Stericycle, and include:

- Reducing COC concentrations in soil beneath CI Plant 4 to less than the preliminary cleanup levels for the Site to reduce inhalation risks to acceptable levels (Table 1); and
- Reducing COC concentrations in shallow groundwater that allegedly originated from CI Plant 4 to less than the preliminary cleanup levels for the Site.

---

[2] *Quality Assurance Project Plan, Appendix B of the Remedial Investigation Work Plan, Capital Industries, Inc., 5801 Third Avenue South, Seattle, Washington* dated September 16, 2008 prepared by Farallon for Mr. Ron Taylor, Capital Industries, Inc.

# 2.0 PROJECT ORGANIZATION

The project organization for conducting the scope of work described in the Work Plan, including identification of key personnel and their responsibilities, is presented below.

## 2.1 KEY PERSONNEL

Farallon has been contracted by CI to plan and implement the Work Plan. The Project Contact for CI is:

Mr. Ron Taylor
Capital Industries, Inc.
5801 3rd Avenue South
Seattle, Washington 98108
Telephone: (206) 292-2608
Fax: (206) 292-2601

The Principal for Farallon is:

Mr. Jeffrey Kaspar, L.G., L. H.G.
Farallon Consulting, L.L.C.
975 5th Avenue Northwest
Issaquah, Washington 98027
Telephone: (425) 295-0800
Fax: (425) 427-0850
jkaspar@farallonconsulting.com

The Project Manager for Farallon is:

Ms. Jennifer Moore
Farallon Consulting, L.L.C.
975 5th Avenue Northwest
Issaquah, Washington 98027
Telephone: (425) 295-0800
Fax: (425) 295-0850
jmoore@farallonconsulting.com

The Project QA/QC Officer for Farallon is:

Ms. Jeanette Mullin
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Issaquah, Washington 98027
Telephone: (425) 295-0800

Fax: (425) 295-0850
jmullin@farallonconsulting.com

The Document Control Clerk for Farallon is:

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Fax: (425) 295-0850
cagostino@farallonconsulting.com

The Project Manager for Ecology is:

Mr. Ed Jones
Washington State Department of Ecology
Northwest Regional Office
3190 160th Avenue Southeast
Bellevue, Washington 98008-5452
Telephone: (425) 649-7000
Fax: (425) 649-7098
ejon461@ecy.wa.gov

## 2.2 KEY PERSONNEL RESPONSIBILITIES

The responsibilities of key personnel involved in the interim action are described below.

### 2.2.1 Project Manager

The Project Manager has overall responsibility for developing the QAPP, monitoring the quality of the technical and managerial aspects of the project, and implementing the QAPP and corresponding corrective measures where necessary.

### 2.2.2 Project QA/QC Officer

The Project QA/QC Officer is responsible for ensuring that personnel assigned to the project meet the training requirements of the QA/QC program, monitoring the project work, and verifying that the project work is performed in accordance with the Work Plan and with other established standard operating procedures for the sampling being performed. Additional responsibilities include reviewing and verifying the disposition of nonconformance and corrective action reports.

The Project QA/QC Officer also has the responsibility to assess the effectiveness of the QA/QC program, and to recommend modifications to the program as appropriate.

### 2.2.3 Project Staff

Project staff are responsible for understanding and implementing the QA/QC program as it relates to the Work Plan objectives.

### 2.2.4 Regulatory Agency

The interim action scope of work presented in the Work Plan is being conducted in accordance with the Agreed Order; the Washington State Model Toxics Control Act Cleanup Regulation, as established in WAC 173-340-350; and the *Final Capital Industries Plant 4 Interim Action Work Plan, West of 4th Group Site, Capital Industries, Inc., 5815 4th Avenue South, Seattle, Washington* dated December 21, 2017 prepared by Farallon for the West of 4th Avenue Group, Site Unit 2 Joint Deliverable, CI, Blaser Die Casting Co., and Stericycle, with Ecology serving as the lead regulatory agency.

# 3.0 DATA QUALITY OBJECTIVES

The DQOs for this project will be used to develop and implement procedures to ensure that the data collected are of sufficient quality to adequately address the interim action objectives presented in the Work Plan. Observations and measurements will be made and recorded in a manner so as to yield results representative of the media and conditions observed and/or measured. Goals for representativeness will be met by ensuring that sampling locations are selected properly, a sufficient number of samples are collected, and field screening and laboratory analyses are conducted properly.

The quality of the laboratory data will be assessed according to the parameters of precision, accuracy, representativeness, completeness, and comparability. The definitions of these parameters and the applicable QC procedures are presented in Sections 3.2, Precision, through 3.6, Comparability. Quantitative DQOs for the parameters precision, accuracy, and completeness are provided following each definition. Laboratory DQOs have been established by the analytical laboratory.

## 3.1 QUANTITATION LIMITS AND QUALITY CONTROL CRITERIA

The laboratory practical quantitation limits, method detection limits, sample containers and preservatives, and sample holding times for the COCs and other analytes in soil and groundwater are shown in Table 2. The actual practical quantitation limit or method detection limit for soil and groundwater samples may be higher, depending on the sample matrix, matrix interferences, and laboratory dilution factors.

## 3.2 PRECISION

Precision is defined as the degree of agreement between or among independent, similar, or repeated measures, and is expressed in terms of analytical variability. For this project, analytical variability will be measured as the relative percent difference (RPD) or coefficient of variation between analytical laboratory duplicates, and between the matrix spike (MS) and matrix spike duplicate (MSD) analyses. Monitoring and sampling variability will be measured by analysis of blind field-replicate samples.

Precision will be calculated as the RPD as follows:

$$RPD = \frac{|S-D|}{(S+D)/2} \times 100$$

where:

RPD = relative percent difference for compound
S = analyte concentration in original sample
D = analyte concentration in duplicate sample

The tolerance limit for percent differences between laboratory duplicates will be ±20 percent; deviations from these criteria will be reported. If the QAPP criteria are not met, the laboratory will provide an explanation of why the limits were exceeded, and will implement appropriate corrective actions for laboratory control samples (LCSs)/LCS duplicates only. RPDs will be evaluated during data review and validation. The independent data reviewer will note deviations from the specified limits, and will comment on the effect of the deviations on reported data. If precision limit exceedances are linked to field sampling, those field sampling procedures will be reviewed, and any problems will be identified. Re-sampling and re-analysis may be required.

There are no specific RPD criteria for organic chemical analyses. Quantitative RPD criteria for organic analyses will be based on laboratory-derived control limits.

Field duplicate samples will be collected during sampling for analysis for chlorinated volatile organic compounds (CVOCs) to assess the precision of laboratory analytical and field sampling methods. Soil sampling is subject to potentially wide ranges of variability due to the heterogeneity of the sample and the limited mass of soil sampled. Conversely, a medium such as groundwater is not as susceptible to the effects of heterogeneity, and is a more-reliable medium for establishing measures of precision and/or accuracy. A limited number of co-located field duplicate soil samples will be collected and analyzed for CVOCs and/or potassium permanganate to confirm the distribution and effectiveness of the injections. One duplicate groundwater sample per Stage 1 groundwater monitoring event will be collected and analyzed for CVOCs.

## 3.3 ACCURACY

Accuracy (bias) is a statistical measurement of correctness and includes components of random error (i.e., variability due to imprecision) and systematic error. It therefore reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ excessively from the known concentration of the spike or standard.

Accuracy measures the bias in a measurement system and is difficult to measure for the entire data collection activity. Sources of error include the sampling process, field contamination, preservative handling, sample matrix effects, and sample preparation and analysis techniques. To confirm that the samples collected are not contaminated, laboratory method blank samples will be analyzed.

Accuracy will be calculated as percent recovery of analytes as follows:

$$R_i = (Y_i/X_i) \times 100$$

where:

$R_i$ = percent recovery for compound i

$Y_i$ = measured analyte concentration of compound i in sample i (measured minus original sample concentration)

$X_i$ = known analyte concentration of compound i in sample i

Laboratory MSs and surrogates will be carried out at the analytical laboratory in accordance with U.S. Environmental Protection Agency (EPA) SW-846 *Test Methods for Evaluating Solid Waste: Physical /Chemical Methods Compendium* requirements for organic chemical analyses. The frequency for both MS and MSD analysis will be 1 per batch of 20 or fewer samples. Quantitative percent recovery criteria for organic analyses will be based on laboratory-derived control limits for surrogate recovery and MS results.

The resultant percent recovery will be compared to the acceptance criteria defined in the QAPP; deviations from specified limits will be reported. If the objective criteria are not met, the laboratory will provide an explanation of why acceptability limits were exceeded, and will implement appropriate corrective actions. Percent recoveries will be reviewed during data validation;

deviations from the specified limits will be noted. The data reviewer will comment on the effect of the deviations on reported data.

### 3.3.1 Laboratory Method Blanks

The laboratory will analyze method blanks at a minimum frequency of 5 percent (or one per batch) to assess potential contamination of the sample in the laboratory.

### 3.3.2 Trip and Temperature Blanks

Laboratory-supplied trip blanks will accompany soil and groundwater samples collected for analysis for CVOCs during performance monitoring events for the interim action. These trip blanks will serve the dual purpose of temperature blanks for the laboratory. The trip/temperature blank for soil samples will be analyzed for CVOCs by EPA Method 8260C to assess the integrity of the sample containers during transport. The trip/temperature blank for groundwater samples will be analyzed for CVOCs by EPA Method 8260D for the baseline sampling event, the first sampling event, and every other sampling event thereafter when CVOCs are analyzed.

A temperature blank will be prepared to accompany any soil samples submitted to Carus Corporation for analysis for potassium permanganate. The trip/temperature and temperature blanks will be checked for temperature by sample-receiving personnel at the laboratories to ensure that the soil and groundwater samples arrived at the correct temperature.

## 3.4 REPRESENTATIVENESS

Representativeness is a qualitative assessment of how closely the measured results reflect the actual concentration or distribution of the constituent concentrations in the matrix sampled. The sampling plan design, sample collection techniques, sample handling protocols, sample analysis methods, and data review procedures have been developed to ensure that the results obtained are representative of CI site conditions. These issues are addressed in detail in Section 4, Data Collection Approach. Representativeness also will be determined by evaluating holding times, sample preservation, and blank contamination. Samples with expired holding times, improper preservation, or blank contamination may not be representative.

## 3.5 COMPLETENESS

Completeness is defined as the percentage of measurements judged to be valid. Valid and invalid data (i.e., data rejected by the laboratory and marked with an R qualifier) will be identified during independent data review. Validation is described in Section 6.5, Data Reduction and Analysis. Completeness is calculated as follows:

$$Completeness = \frac{(Number\ of\ Valid\ Measurements)}{(Total\ Number\ of\ Measurements)}\ x\ 100$$

The objectives for completeness of samples are expressed as percentages, and refer to the minimum acceptable percentages of samples received at the laboratory in good condition and acceptable for analysis. Objectives for completeness are based in part on the subsequent uses of the data: the more critical the use, the greater the completeness objective. The objective for completeness is 95 percent for groundwater samples and 90 percent for soil samples. These objectives will be met though the use of proper sample containers, proper sample packaging procedures to prevent breakage during shipment, proper sample preservation, and proper labeling and chain-of-custody procedures. A loss of 5 to 10 percent of intended samples due to refusal or poor sample recovery is common. When feasible, the amount of each sample collected will be sufficient for re-analysis of the sample should the initial results not meet QC requirements. The goals set for the RI project are considered sufficient for the intended data uses.

The objectives for completeness of chemical analyses also are expressed as percentages, and refer to the percentages of analytical requests for which usable analytical data are produced. The initial objective for completeness of chemical analyses in the laboratory is 95 percent.

Sampling and analysis data critical to achieving the objectives for completeness include soil and groundwater data that reflect the expected decrease in COC concentrations as a result of the interim action.

If overall completeness is less than the stated goal, CI will assess the reason for the lack of completeness, which may include DQOs based on poor assumptions, or a work plan poorly implemented or difficult to carry out. If DQOs are achieved despite lack of completeness, no further work will be performed. If DQOs are not achieved, further sample collection may be necessary, and will be carried out under advisement from Ecology.

## 3.6 COMPARABILITY

Comparability is the degree to which data from one study can be compared with data from historical studies at the same location, other similar studies, reference values (such as background concentrations), reference materials, and screening values.

The following approach will be used to review data generated by CI to ensure sufficient quality for use during the interim action and feasibility study:

- Standard sampling techniques will be used during field investigation activities.
- The analytical laboratory will be certified by Ecology and the National Environmental Laboratory Accreditation Program.
- Methods approved by EPA and Ecology will be used. QC samples and standard operating procedures will be used by the laboratory to ensure that reporting standards are maintained in accordance with the Laboratory Quality Assurance Plan.
- The laboratory-provided data reports will be similar to those developed as part of the EPA Contract Laboratory Program for all analyses requiring definitive data. The complete data report and corresponding documentation will be sufficient to perform an appropriate level of data validation.
- Data quality review and validation will be performed on the analytical data according to the procedures specified in this QAPP.

# 4.0 DATA COLLECTION APPROACH

Procedures that will be used to collect, preserve, transport, and store samples are described in the Sampling and Analysis Plan, provided as Appendix C of the Work Plan (SAP). Sampling protocols will be performed in accordance with generally accepted environmental practices, and will meet or exceed current regulatory standards and guidelines. Sampling procedures may be modified, if necessary, to satisfy amendments to current regulations, methods, or guidelines. Sample containers, preservation methods, and holding times are presented the SAP.

# 5.0 ANALYTICAL PROCEDURES

OnSite Environmental Inc. of Redmond, Washington (OnSite) and Carus Corporation have been selected as the laboratories to conduct the analyses for COCs in soil and groundwater. OnSite is certified by Ecology, and meets the QA/QC requirements of both Ecology and EPA. Carus Corporation's laboratory is ISO 9001:2015 certified.

The contact for OnSite is:

Mr. David Baumeister
OnSite Environmental Inc.
14648 Northeast 95th Street
Redmond, Washington 98052
Telephone: (425) 883-3881

The contact for Carus Corporation is:

Mr. Dylan Kemmerer
Carus Corporation
1500 8th Street
LaSalle, Illinois 61301
Telephone: (815) 224-6813

A copy of the laboratory Quality Assurance Manual, Revision No. 9.6 dated April 17, 2018 prepared by OnSite, which will be followed by the laboratory throughout the interim action, is on file at the Farallon office for review and reference. Ecology will have access to laboratory personnel, equipment, and records pertaining to sample collection, transportation, and analysis. The specific analytical methods, sample preservation methods, and container requirements for the soil and groundwater samples are defined in the SAP.

# 6.0 DATA MANAGEMENT AND REPORTING

This section outlines the procedures to be followed for the inventory, control, storage, and retrieval of data collected for the scope of work presented in the Work Plan. The procedures contained in the QAPP are designed to ensure that the integrity of the collected data is maintained for subsequent use.

## 6.1 DATA TYPES

A variety of data will be generated, including sampling and analytical data. Examples of data types include electronically reported laboratory data and manually recorded field data such as soil descriptions. Laboratory analytical data will be transmitted to Farallon both as an electronic data deliverable file and as a portable document format (PDF) laboratory data report, which will facilitate validation and analysis of these data while avoiding transcription errors that may occur with computer data entry.

## 6.2 DATA TRANSFER

Procedures controlling the receipt and distribution of incoming data packages to Farallon and the transmittal of outgoing data reports from Farallon are outlined below.

### 6.2.1 Receipt of Data and Reports

Analytical data will be received from the analytical laboratory in PDF and electronic data deliverable formats. Incoming documents, such as PDF copies of laboratory analytical reports, will be date-stamped and filed electronically. Correspondence and transmittal letters for reports, maps, and data will be filed chronologically. Data packages such as those from field personnel and laboratories (e.g., soil analytical data, soil condition observations) will be filed by project task, subject heading, and date. If distribution of a document is required, the number of needed copies will be made and distributed to the appropriate persons or agencies, and recorded on a document transmittal form.

Analytical data received in electronic data deliverable format will be uploaded into an EQuIS database, and checked against the PDF of the laboratory analytical report.

### 6.2.2 Outgoing Data and Reports

A transmittal sheet will be attached to all project data and reports sent out by Farallon. A copy of each transmittal sheet will be kept in the administrative file and in the project file. The Project Manager or the Project QA/QC Officer will review outgoing documents.

## 6.3 DATA INVENTORY

Procedures for the filing, storage, and retrieval of project data and reports are discussed below.

### 6.3.1 Document Filing and Storage

Project files and raw data files will be maintained at the Farallon office. Files will be organized by project task or subject heading, and maintained by the Document Control Clerk. Electronic files will be maintained in a project directory and backed up. The electronic files will be stored on password-protected Microsoft servers with secure firewall protection. In accordance with WAC 173-340-850, the hard copy and electronic project files will be archived for a minimum of 10 years after completion of compliance monitoring, or as long as any institutional controls remain in effect.

### 6.3.2 Access to Project Files

Access to project files will be controlled, and limited to CI and its authorized representatives, Ecology, and Farallon personnel. When a hard-copy file is removed for use, a sign-out procedure will be used to track document custody. If a document is to be used for an extended period, a copy will be made, and the original will be returned to the project file. The final version of reports, tables, and figures in electronic format will be write-protected in the project directory.

## 6.4 DATA QUALITY REVIEW

Data quality review will be performed where applicable using the *Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs, Part 1: UFP-QAPP Manual* dated March 2005 (EPA Publication No. EPA-505-B-04-900A), the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Quality Review* dated October 1999 (EPA Publication No. 540/R-99/008), and the *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (Final) dated January 2010 (EPA Document No. EPA 540-R-10-011).

All laboratory data will be verified by Farallon personnel versed in basic data validation criteria as defined in the aforementioned references. The following types of QC information will be reviewed, as appropriate:

- Method deviations;
- Sample extraction and holding times;
- Method reporting limits;
- Blank samples (equipment rinsate and laboratory method);
- Duplicate samples;
- MS/MSD duplicate samples (accuracy);
- Surrogate recoveries;
- Percent completeness and RPDs (precision); and
- Final analytical data packages for samples collected during the interim action.

Laboratory QC limits will be provided by the laboratory and evaluated as part of the data validation process. QC limits may vary as a result of matrix interference and changes in laboratory control limits at the time of sample analysis.

## 6.5 DATA REDUCTION AND ANALYSIS

The Project Manager and Project QA/QC Officer are responsible for data review and validation in adherence to the parameters outlined in Section 3, Data Quality Objectives. The type of analyses and presentation methods selected for any given data set will depend on the type, quantity, quality, and prospective use of those data. Analysis of project data will require data reduction for preparation of tables, charts, and maps. To ensure that data are accurately transferred during the reduction process, two data reviews will be performed before the documents are issued: one by the Project QA/QC Officer or Project Manager, and the second by the Project Principal. Any incorrect transfer of data will be highlighted and corrected.

Physical and chemical characterization information will be presented in the format described below.

### 6.5.1 Summary Tables and Plots

To facilitate assimilation and presentation, laboratory reports will be sorted according to various parameters to summarize the information contained. Soil and groundwater sampling analytical data will be sorted several ways, including by sample identification number, constituent, and date of sample collection. The parameters chosen for sorting will depend on the requirements for the most-appropriate format and the utility of that format in demonstrating the physical and chemical characteristics of interest. Data collected to document the injection process will be recorded in field notes that will be reviewed by the Project QA/QC Officer following translation onto summary tables and/or plots to ensure that the data have been accurately translated to facilitate evaluation of interim action data.

### 6.5.2 Figures

Figures needed to illustrate results will be assembled or prepared. These figures may include but are not limited to plan maps of the CI property and surrounding areas showing confirmed and suspected sources, injection boring locations, sampling locations, chemical concentrations for individual chemicals and groups of chemicals, COC distribution figures, CI property features, and/or potential preferential pathways (e.g., sewer lines).

# 7.0 QUALITY CONTROL PROCEDURES

This section provides a description of the QC procedures pertaining to both field activities and laboratory analysis. The QC procedures for field activities entail standard operating procedures for sample collection and handling, including field QC samples, and for equipment calibration.

## 7.1 FIELD QUALITY CONTROL

Field QC samples (e.g., field duplicate samples, trip blanks, and MS/MSD samples) will be collected as described in the SAP. The purpose of these samples is discussed in Section 3, Data Quality Objectives. Standard operating procedures also will be implemented during field activities. The procedural basis for these field data collection activities and deviations from established protocols will be documented on the Field Report forms.

## 7.2 LABORATORY QUALITY CONTROL

Analytical laboratory QA/QC procedures for OnSite are described in its laboratory Quality Assurance Manual. The manual is available through OnSite if requested, and will be referenced by Farallon in reviewing the data provided by OnSite.

## 7.3 DATA QUALITY CONTROL

The laboratory will perform in-house analytical data reduction under the direction of the analytical laboratory QA Manager. The laboratory data-reduction procedures will be those specified in EPA- and Ecology-approved methods, and those described in the laboratory procedures delineated in the laboratory Quality Assurance Manual. The data-reduction steps will be documented, signed, and dated by the laboratory. Data reduction will be conducted as follows:

- Raw data produced will be processed, and reviewed for compliance with the QC criteria established in this QAPP. The raw data will be reviewed also for overall reasonableness, and for transcription or calculation errors.
- After the data have been entered into the Laboratory Information Management System, a computerized report will be generated and sent to the analytical laboratory QA Manager.

- The need for any sample re-analysis will be assessed. Upon discovery that an analysis fails to meet the required data quality criteria, the Project QA/QC Officer will be contacted to discuss noncompliant data sets. If corrective actions have been taken and data still do not meet project QA requirements, the Project Manager will be notified.
- Upon acceptance of the preliminary data reports by the analytical laboratory, final analytical reports will be generated. Final analytical reports will be available within approximately 30 calendar days of sample submittal.

### 7.3.1 Data Validation

The activities to be undertaken to validate the laboratory analytical data generated are described below.

#### 7.3.1.1 Compliance

The laboratory will assign QC qualifiers (as described and defined in the Laboratory Quality Assurance Manual) if any of the following occurs:

- The concentration of the chemical is less than the required reporting limit, or exceeds calibration limits;
- The concentration of the chemical is less than the required reporting limit, but exceeds the method detection limit;
- The chemical is found also in the laboratory blank;
- Spiking analyte recoveries (bias) is outside project-specified control limits (inorganic analyses only);
- Laboratory duplicate precision is outside project-specified control limits (inorganic analyses only); or
- Surrogate recoveries and laboratory duplicate precision are out of control limits for organic analyses.

Other sample-specific qualifiers will be added to describe QC conditions as necessary. The laboratory will maintain detailed procedures for laboratory record-keeping that support the validity of the analytical work completed. Each data report package submitted will contain the laboratory's written certification that the requested analytical method was run and that all QA/QC checks were performed.

The analytical laboratory has the initial responsibility for verifying the correctness and completeness of the data, based on an established set of guidelines and project QC criteria. The following verification will be made:

- Documentation of sample receipt and handling is complete;
- Sample preparation information is correct and complete;
- Analytical information is correct and complete;
- Raw data, including manual integrations, have been interpreted correctly;
- Appropriate preparation and analytical procedures have been followed;
- Special sample preparation and analytical requirements specific to the Site or project have been met;
- Analytical results have been calculated correctly and are complete;
- QC sample results are within project QC limits;
- Laboratory blanks are within project QC limits; and
- Documentation is complete: all anomalies in preparation and analysis have been documented, holding times have been documented, and all data (including data generated before and after corrective actions or cleanup has been conducted) are included in the laboratory data report.

Qualified laboratory personnel other than the original laboratory analyst will provide an independent peer review of the analytical data package to ensure the following QC elements:

- Appropriate laboratory standard operating procedures have been referenced;
- Calibration data are scientifically sound and appropriate to the method;
- QC sample data are within project-specific limits;

- Qualitative and quantitative results are correct;
- Raw data, including manual interpretations, have been correctly interpreted; and
- Documentation is correct and complete.

#### 7.3.1.2 Comparison

The laboratory data will be validated by Farallon personnel versed in data validation. Data review for this process involves the following elements:

- Assessment of data reliability based on QC sample results;
- Verification that requirements set forth in the project planning documents have been met; and
- Assessment of data usability.

Data review will include evaluation of laboratory summary data for precision, accuracy, representativeness, comparability, and completeness, and a summary of qualified data. Data review will not include review of raw data or recalculation of reported results. The data review summary will provide a list of all samples reviewed, a narrative summarizing each review topic (e.g., calibration, holding times), qualified results, worksheets, and any data resubmitted by the laboratory at the request of the reviewer, including chromatographs.

The data validation process for this project will follow the procedures specified in the EPA *National Functional Guidelines for Superfund Organic Methods Data Review* dated August 2014 (EPA Publication No. EPA 540-R-014-002), modified for the methods used and for project-specific criteria. The data validation process will include verification of the following:

- Compliance with the QAPP;
- Sample preservation and handling procedures;
- Holding times;

- Method detection limit and method reporting limit;
- QC results (e.g., surrogate, MS/MSD, and LCS recoveries; MS/MSD, field duplicate, and laboratory duplicate RPDs; serial dilutions);
- Laboratory blank and trip blank analyses;
- Data completeness and format; and
- Data qualifiers assigned by the laboratory.

Qualifiers will be added to data during review as necessary. Qualifiers applied to data as a result of the review will be limited to the following designations:

U = The analyte was analyzed for, but was not detected at a concentration exceeding the sample-specific reporting limit.

J = The analyte was positively identified, and the associated numerical value is an estimate of the concentration of the analyte in the sample.

UJ = The analyte was not detected at a concentration exceeding the sample reporting limit, although the reporting limit is approximate, and may or may not represent the actual limit of quantitation.

R = The analyte results are rejected due to serious deficiencies in the ability to analyze the sample and meet QC criteria. The presence or absence of the analyte cannot be verified.

### 7.3.2 Field Data Verification

Farallon will review field records and results from field observations and measurements to ensure that procedures were properly performed and documented. The review of field procedures will include the following factors:

- Completeness and legibility of field logs;

- Preparation and frequency of field QC samples;
- Equipment calibration and maintenance; and
- Chain of Custody forms.

Corrective actions for procedure violations are described in Section 10, Corrective Action.

## 7.4 DATA ASSESSMENT PROCEDURES

The Project Manager and Project QA/QC Officer are responsible for data review and validation. Upon receipt of each data package from the laboratory, calculations for precision, accuracy, and completeness will be performed using the equations presented in Section 3, Data Quality Objectives. Results will be compared to quantitative DQOs where established, or to qualitative DQOs. The data validation parameters are outlined in Section 3, Data Quality Objectives.

# 8.0 PERFORMANCE AND SYSTEM AUDITS

Performance audits will be conducted for both sampling and analysis work. Field performance will be monitored through regular review of field notebooks, field measurements, and Chain of Custody forms. The Project Principal, Project Manager, and/or the Project QA/QC Officer also may perform periodic on-site review of work in progress.

Ecology accreditation of the analytical laboratory for each type of analysis performed demonstrates the laboratory's ability to properly perform the requested methods. Therefore, a system audit of the analytical laboratories will not be conducted during the course of this project.

The Project Manager and/or Project QA/QC Officer will frequently oversee communication with the analytical laboratories while samples are being processed and analyzed at the laboratories. This oversight will allow Farallon to assess progress toward the DQOs, and to take corrective measures, if necessary.

The analytical laboratories are responsible for identifying (and correcting, as appropriate) any deviation from performance standards. The laboratories will communicate to the Project Manager or the Project QA/QC Officer any deviation from the performance standards, and the appropriate corrective measures taken during sample analysis. Corrective actions are discussed in Section 10, Corrective Action.

# 9.0 PREVENTIVE MAINTENANCE

Operation and maintenance manuals will accompany field parameter analysis and measurement equipment. Included in these manuals will be procedures for calibration, operation, and troubleshooting. Maintenance activities will be documented in the project Field Report forms and/or equipment logbooks. A schedule of preventive maintenance activities will be maintained. Spare parts and tools will be included in each equipment storage case to minimize equipment downtime.

# 10.0 CORRECTIVE ACTION

Corrective actions will be the joint responsibility of the Project Manager and the Project QA/QC Officer. Corrective procedures may include:

- Identifying the source of the violation;
- Re-analyzing samples if holding time criteria permit;
- Re-sampling and analyzing;
- Re-measuring the parameter;
- Evaluating and amending sampling and analytical procedures; and/or
- Qualifying data to indicate the level of uncertainty.

During field sampling operations, the Project Manager and field team members will be responsible for identifying and correcting protocols that may compromise data quality. All corrective actions taken will be documented in the field notes.

# 11.0 QUALITY ASSURANCE REPORTS

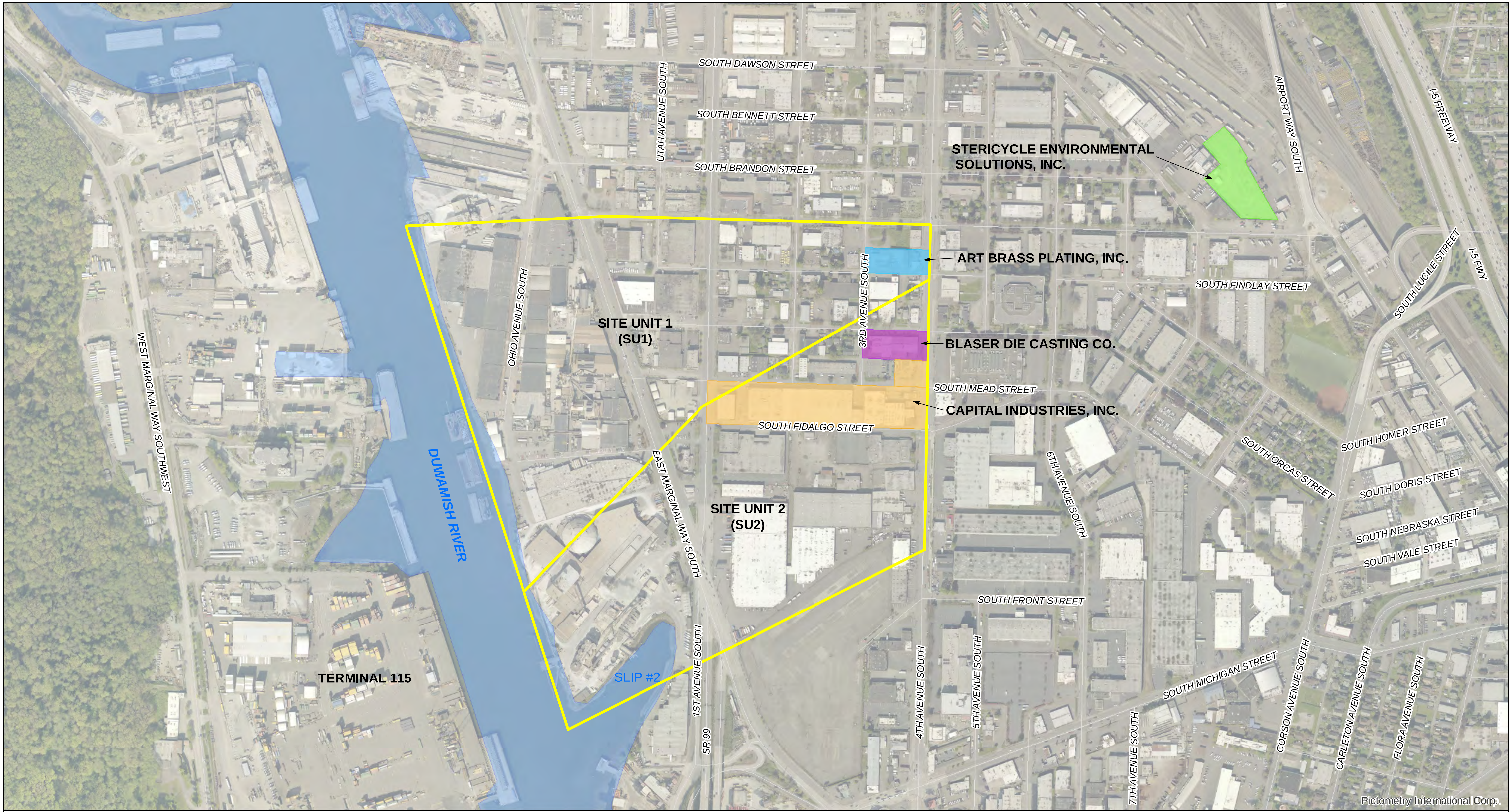
An Interim Action Completion Report will be prepared after Stage 2 of the interim action has been completed and post-interim action confirmation monitoring indicates that interim action objectives have been achieved. The Interim Action Completion Report will summarize the results from the interim action, and will include a QA section summarizing the data quality of the deliverables that are generated during the project. At a minimum, this summary will include:

- An assessment of data precision, accuracy, representativeness, completeness, and comparability;
- A discussion of data validation results;
- A discussion of data usability;
- The results from performance and/or system audits; and
- Identification of significant QA problems and the impact on the DQOs.

# FIGURES

QUALITY ASSURANCE PROJECT PLAN,
APPENDIX D OF THE REVISED CAPITAL INDUSTRIES PLANT 4
STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site,
Capital Industries, Inc.
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008



LEGEND

🟦 ART BRASS PLATING, INC.
🟪 BLASER DIE CASTING CO.
🟧 CAPITAL INDUSTRIES, INC.
🟩 STERICYCLE ENVIRONMENTAL SOLUTIONS, INC.
☐ SITE UNIT BOUNDARY

DRAFT

N

0 250 500
SCALE IN FEET

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Issaquah | Bellingham | Seattle

Oregon
Portland | Bend | Baker City

California
Oakland | Folsom | Irvine

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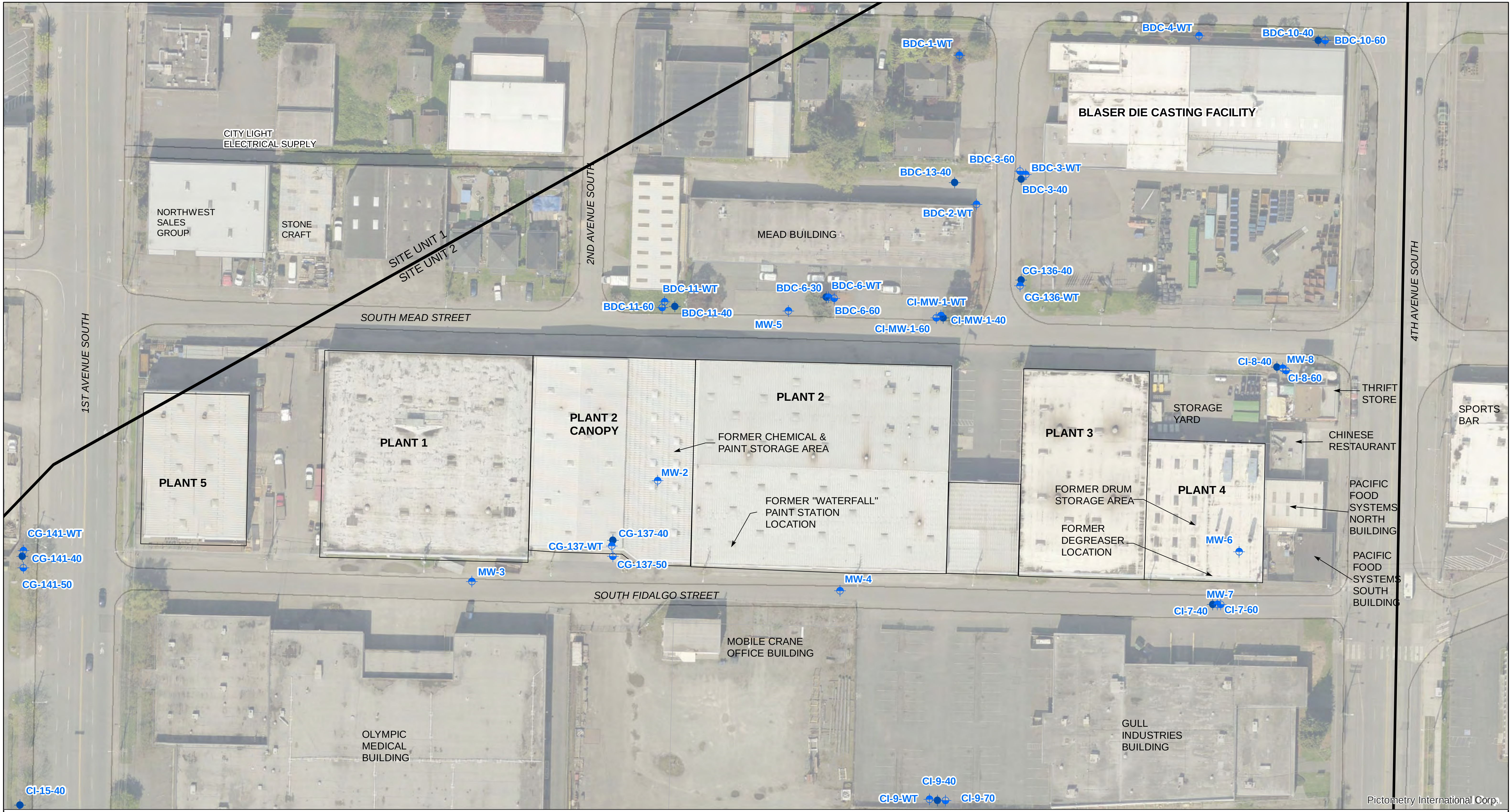
# FIGURE 1

SITE DIAGRAM
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5801 3RD AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: tperrin
Checked By: JK
Date: 5/7/2018
Disc Reference:
Document Path: Q:\Projects\457 CapitalIndust\008 PilotStudy\InterimWorkPlan\Revision 20180507\Figure1 Sitemap.mxd



## LEGEND

- ⌖ WATER TABLE INTERVAL MONITORING WELL
- ● SHALLOW INTERVAL MONITORING WELL
- ⌖ INTERMEDIATE INTERVAL MONITORING WELL
- ▭ SITE UNIT BOUNDARY
- ▭ BUILDINGS

N

0 40 80
SCALE IN FEET

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Portland | Bend | Baker City

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# FIGURE 2

## PROPERTY DIAGRAM
## WEST OF 4TH GROUP SITE
## CAPITAL INDUSTRIES, INC.
## 5801 3RD AVENUE SOUTH
## SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: tperrin
Checked By: JK
Date: 5/7/2018
Disc Reference:
Document Path: Q:\Projects\457 CapitalIndust\008 PilotStudy\InterimWorkPlan\Revision_20180507\Figure2_PropertyDiagram.mxd

# TABLES

QUALITY ASSURANCE PROJECT PLAN,
APPENDIX D OF THE REVISED CAPITAL INDUSTRIES PLANT 4
STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site,
Capital Industries, Inc.
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

# Table 1
# Summary of Preliminary Cleanup Levels
## Updated January 17, 2017
## West of 4th Group Site
## Capital Industries, Inc.
## 5801 3rd Avenue South
## Seattle, Washington
## Farallon PN: 457-008

| | | Preliminary Cleanup Levels | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil | | | | | Groundwater | | | | Air | | Surface Water | | Sediment |
| Constituent of Concern | Carcinogen or Non-Carcinogen | Puget Sound Background Concentrations for Metals[1] | Soil Cleanup Level Protective of Direct Contact Pathway (Unrestricted Land Use)[2] | Soil Cleanup Level Protective of Direct Contact Pathway (Industrial Land Use)[2] | Soil Cleanup Level Protective of Air Quality Based on Protection of Groundwater as Potable Drinking Water[3] | Soil Cleanup Level Protective of Groundwater Concentrations Protective of Surface Water Quality[4] | Groundwater Cleanup Level Protective of Air Quality Water Table Zone (Unrestricted Land Use)[5] | Groundwater Cleanup Level Protective of Air Quality Water Table Zone (Industrial Land Use)[5] | Groundwater Cleanup Level Protective of Surface Water[6] | Groundwater Cleanup Level Protective of Sediment[7] | Air Cleanup Level Protective of Inhalation Pathway (Unrestricted Land Use)[2] | Air Cleanup Level Protective of Inhalation Pathway (Industrial Land Use)[2] | Surface Water Cleanup Level Protective of Human Health[8] | Surface Water Cleanup Level Protective of Aquatic Life | Sediment Cleanup Level[9] |
| | | (milligrams/kilogram) | | | | | (micrograms/liter) | | | | (micrograms/cubic meter) | | (micrograms/liter) | | (milligrams/kilogram) |
| Tetrachloroethene | Carcinogen | -- | 476 | 21,000 | 0.08 | 0.044 | 116 | 482 | 2.9 | 36,000 | 9.6 | 40 | 2.9 | -- | 190 |
| Trichloroethene | Carcinogen | -- | 12 | 1,750 | 0.03 | 0.006 | 6.9 | 37 | 0.7 | 4,760,000 | 0.37 | 2 | 0.7 | 194 [12] | 8,950 |
| cis-1,2-dichloroethene | Non-Carcinogen | -- | 160 | 7,000 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| trans-1,2-dichloroethene | Non-Carcinogen | -- | 1,600 | 70,000 | 0.59 | 6 | 559 | 1,224 | 1,000 | -- | 27.4 | 60 | 1,000 | -- | -- |
| 1,1-dichloroethene | Non-Carcinogen | -- | 4,000 | 175,000 | 0.055 | 0.025 | 538 | 1,176 | 3.2 | -- | 91.4 | 200 | 3.2 | -- | -- |
| Vinyl chloride | Carcinogen | -- | 0.67 | 87.5 | 0.002 | 0.001 | 1.3 | 12.7 | 0.18 | 543,000 | 0.28 | 2.8 | 0.18 | 210 [13] | 202 |
| 1,4-dioxane | Carcinogen | -- | 10 | 1,310 | 0.004 | 0.32 | 2,551 | 25,510 | 78 | -- | 0.5 | 5 | 78 | -- | -- |
| Arsenic | Carcinogen | 20 | 20 | 87.5 | Not Applicable | 0.082 | Not Applicable | Not Applicable | 0.14 / 5 [10] | 241 | Not Applicable | Not Applicable | 0.14 / 5 [10] | 36 [14] | 7 |
| Barium | Non-Carcinogen | -- | 16,000 | 700,000 | Not Applicable | 824 | Not Applicable | Not Applicable | -- | -- | Not Applicable | Not Applicable | -- | -- | -- |
| Cadmium | Non-Carcinogen | 1 | 80 | 3,500 | Not Applicable | 1.2 | Not Applicable | Not Applicable | 8.8 | 760 | Not Applicable | Not Applicable | -- | 8.8 [15] | 5.1 |
| Copper | Non-Carcinogen | 36 | 3,200 | 140,000 | Not Applicable | 1.1 | Not Applicable | Not Applicable | 3.1 [11] | 18,000 | Not Applicable | Not Applicable | -- | 3.1 [15] | 390 |
| Iron | Non-Carcinogen | 58,700 | 58,700 | 2,450,000 | Not Applicable | -- | Not Applicable | Not Applicable | -- | -- | Not Applicable | Not Applicable | 1,000 | -- | -- |
| Manganese | Non-Carcinogen | 1,200 | 11,200 | 490,000 | Not Applicable | -- | Not Applicable | Not Applicable | 100 | -- | Not Applicable | Not Applicable | 100 | -- | -- |
| Nickel | Non-Carcinogen | 48 | 1,600 | 70,000 | Not Applicable | 11 | Not Applicable | Not Applicable | 8.2 | 2,200 | Not Applicable | Not Applicable | 100 | 8.2 [15] | 15.9 |
| Zinc | Non-Carcinogen | 85 | 24,000 | 1,050,000 | Not Applicable | 101 | Not Applicable | Not Applicable | 81 | 6,600 | Not Applicable | Not Applicable | 1,000 | 81 [15] | 410 |

NOTES:

Preliminary cleanup levels presented represent the most-stringent cleanup levels for the constituent of concern listed in the media indicated.

-- denotes no value is available. In the case of applicable or relevant and appropriate requirements (ARARs), the reference sources do not publish values for the noted chemicals. In the case of calculated values, one or more input parameters are not available.

Not Applicable denotes the constituent of concern will not affect the medium of potential concern due to an incomplete pathway.

[1] Background metals values from *Natural Background Soil Metals Concentrations in Washington State* dated October 1994, Washington State Department of Ecology (Ecology) Publication No. 94-115. Arsenic background from Washington State Model Toxics Control Act Cleanup Regulation (MTCA) Table 740-1, *Method A Soil Cleanup Levels for Unrestricted Land Uses.*

[2] Cleanup level is based on standard MTCA Method B (unrestricted land use) or Method C (industrial land use) values from the Cleanup and Risk Calculations tables (CLARC).

[3] Soil cleanup levels for protection of air quality are calculated using MTCA Equation 747-1, where the potable Method B groundwater cleanup level was used as Cw. Concentrations of hazardous substances in soil that meet the potable groundwater protection standard currently are considered sufficiently protective of the air pathway for unrestricted and industrial land uses.

[4] Soil cleanup levels for protection of surface water quality are calculated using MTCA Equation 747-1, where the groundwater cleanup level protective of surface water in this table was used as Cw.

[5] Groundwater cleanup levels protective of the air pathway for unrestricted land use (residential and commercial sites) and industrial land use were derived using the following equation: Gwcul = Aircul/GIVF.

[6] Human health and marine aquatic ecologic receptors were considered. See Surface Water Cleanup Levels Protective of Human Health and Aquatic Life (Columns N and O) in this table. The more-stringent value of the two receptors has been listed for the Groundwater Cleanup Level Protective of Surface Water.

[7] Groundwater screening levels based on the transfer of contaminants from groundwater to sediment were calculated by dividing the sediment screening level by the associated partition coefficients. Koc and Kd values are from MTCA. Fraction of carbon assumed at 0.02 based on Lower Duwamish Waterway Feasibility Study (AECOM 2012).

[8] The most-stringent exposure pathway for human health receptors is for consumption of fish. Listed values are based on ARARs contained in CLARC, with the following exceptions: (1) 1,4-dioxane is derived from MTCA Method B default values; (2) PCE, TCE, trans-DCE, vinyl chloride, nickel, and zinc are based on the U.S. Environmental Protection Agency (EPA) revised *CWA* [Clean Water Act]-*Human Health Criteria Applicable to Washington* dated November 15, 2016, "Organisms Only."

[9] Sediment has not been confirmed to be affected by groundwater discharge to surface water. Sediment cleanup levels were derived from the Lower Duwamish Waterway Superfund Site Record of Decisions (EPA 2014), which does not contain values for nickel, TCE, PCE, or vinyl chloride. These constituents also are not listed in the Sediment Management Standards (Chapter 173-204 of the Washington Administrative Code [WAC 173-204]). EPA Region III BTAG [Biological Technical Assistance Group] Marine Sediment Screening Benchmarks dated July 2006 have been listed for nickel, TCE, and PCE. EPA Region III has no value listed for vinyl chloride; therefore, the older Region 5 benchmarks were used (EPA 2003).

[10] Arsenic cleanup level of 5 micrograms per liter (µg/l) based on background concentrations for the state of Washington (MTCA Table 720-1).

[11] The surface water cleanup level for copper previously had been tabulated as 2.4 µg/l; however, this value is based on an approach using a site-specific water-effects ratio that has not been determined. This value was replaced with 3.1 µg/l, the National Recommended Water Quality Criteria - Aquatic Life Criteria Table published by EPA under Section 304 of the Federal Clean Water Act.

[12] Based on the Oak Ridge National Laboratory Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota.

[13] DeRooij, C. et al. 2004. *Euro Chlor Risk Assessment for the Marine Environment Osparcom Region: North Sea – Environmental Monitoring and Assessment.*

[14] WAC 173-201A-240.

[15] National Recommended Water Quality Criteria - Aquatic Life Criteria Table published by EPA under Section 304 of the Federal Clean Water Act.

Kd = distribution coefficient
Koc = soil organic carbon-water partition coefficient
PCE = tetrachloroethene
t-1,2-DCE = trans-1,2-dichloroethene
TCE = trichloroethene

Table updated on August 14, 2015 based on revisions to EPA Aquatic Water Quality Criteria; on July 20, 2016 based on Ecology comments on the Draft FS Reports for SU1 and SU2 (i.e., footnotes clarified, sediment values and surface water CULs protective of aquatic life added); and January 17, 2017 based on EPA revisions to the Clean Water Act Human Health criteria dated November 15, 2016.

# Table 2
## Analytical Details
**West of 4th Group Site**
**Capital Industries, Inc.**
**5801 3rd Avenue South**
**Seattle, Washington**
**Farallon PN: 457-008**

| Analyte | Analytical Method | Laboratory PQL | Laboratory MDL | Sample Container(s)/ Preservatives | Sample Hold Time |
|---|---|---|---|---|---|
| **Soil Samples (mg/kg)** | | | | | |
| Tetrachloroethene[1] | EPA 8260C | 0.001 | 0.000453 | 1 x 4-oz CWMJ unpreserved; 2 x 40-ml vials with a stir bar unpreserved; and 2 x 40-ml vials without a stir bar unpreserved | 14 days to analyze |
| Trichloroethene[1] | EPA 8260C | 0.001 | 0.000336 | | |
| cis-1,2-Dichloroethene[1] | EPA 8260C | 0.001 | 0.000236 | | |
| trans-1,2-Dichloroethene[1] | EPA 8260C | 0.001 | 0.000200 | | |
| 1,1-Dichloroethene[1] | EPA 8260C | 0.001 | 0.000209 | | |
| Vinyl Chloride[1] | EPA 8260C | 0.001 | 0.000316 | | |
| Potassium Permanganate[2] | Standard Method SM4500 | 0.36 | 0.11 | 1 x 40-ml vial unpreserved, sealed with electrical tape | 24 hours to analyze |
| Potassium Permanganate Natural Oxidant Demand[2] | ASTM Method D7262-10, Test Method A | 0.72 | 0.22 | 2 x 250-ml CWMJ unpreserved | 28 days to analyze |
| **Groundwater Samples [3]** | | | | | |
| Tetrachloroethene[1] | EPA 8260D | 0.20 | 0.0470 | 3 x 40-ml glass vials preserved with hydrochloric acid at pH<2 | 14 days to analyze |
| Trichloroethene[1] | EPA 8260D | 0.20 | 0.0535 | | |
| cis-1,2-Dichloroethene[1] | EPA 8260D | 0.20 | 0.0431 | | |
| trans-1,2-Dichloroethene[1] | EPA 8260D | 0.20 | 0.0558 | | |
| 1,1-Dichloroethene[1] | EPA 8260D | 0.20 | 0.0455 | | |
| Vinyl Chloride[1] | EPA 8260D | 0.20 | 0.0355 | | |
| Dissolved Arsenic[1] | EPA Method 200.8 | 3.0 | 0.0506 | Field Filter - 1 x 500-ml HDPE preserved with nitric acid with pH<2 or Lab Filter - 1 x 500-ml HDPE unpreserved | 6 months to analyze, 28 days for mercury |
| Dissolved Chromium[1] | EPA Method 200.8 | 10 | 0.0498 | | |
| Dissolved Manganese[1] | EPA Method 200.8 | 10 | 0.0247 | | |
| Dissolved Iron[1] | EPA Method 6010D | 56 | 10.200 | | |
| Dissolved Cadmium[1] | EPA Method 200.8 | 4 | 0.01 | | |
| Dissolved Mercury[1] | EPA Method 7470A/245.1 | 1.0 | 0.0216 | | |
| Dissolved Lead[1] | EPA Method 200.8 | 1.0 | 0.0116 | | |
| Total Chromium[1] | EPA Method 200.8 | 11 | 0.094 | 1 x 500-ml HDPE preserved with nitric acid with pH<2 | 6 months to analyze, 28 days for mercury |
| Total Manganese[1] | EPA Method 200.8 | 11 | 0.668 | | |
| Total Iron[1] | EPA Method 6010D | 56 | 30.8 | | |
| Total Cadmium[1] | EPA Method 200.8 | 11 | 0.1130 | | |
| Total Mercury[1] | EPA Method 7470A/245.1 | 0.50 | 0.00786 | | |
| Total Lead[1] | EPA Method 200.8 | 1.1 | 0.0813 | | |
| Total Dissolved Solids[1] | Standard Method SM2540C | 13.00 | NA | 1 x 250-ml HDPE unpreserved | 7 days to analyze |
| Hexavalent Chromium[1] | Standard Method SM3500-CR B | 10.00 | 2.66 | 1 x 500-ml HDPE unpreserved | 24 hours to analyze |

NOTES:

All samples must have a temperature of ≤ 6 degrees Celsius.

[1] The laboratory practical quantitation limits (PQLs) and method detection limits (MDLs) provided are from OnSite Environmental Inc. of Redmond, Washington.

[2] The laboratory PQLs and MDLs provided are from Carus Corporation of LaSalle, Illinois.

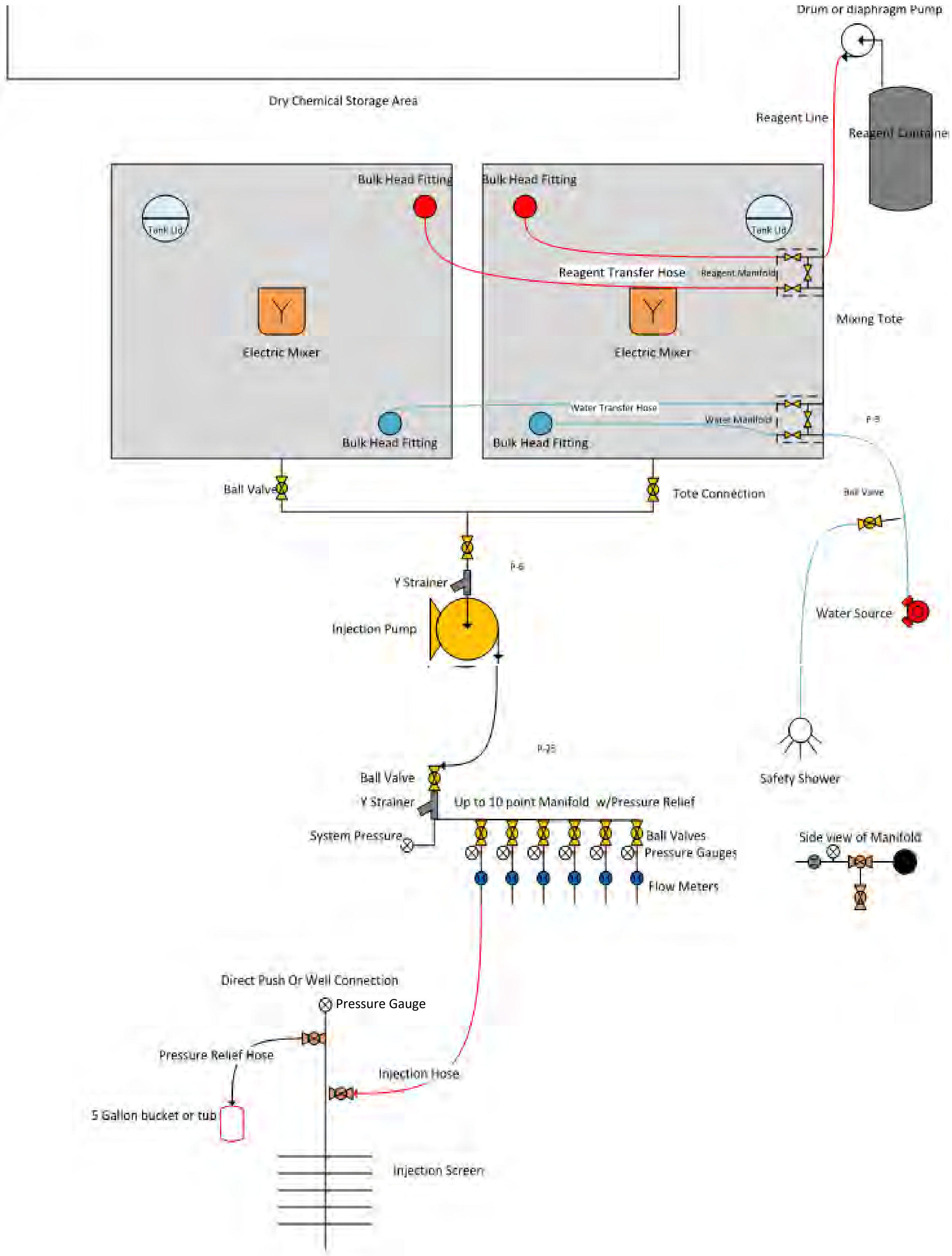
[3] Units of measure for groundwater samples are micrograms per liter (µg/l), except for total dissolved solids, which are measured in milligrams per liter (mg/l).

ASTM = ASTM International
CWMJ = clear wide-mouthed jar
EPA = U.S. Environmental Protection Agency
HDPE = high-density polyethylene
ml = milliliter
NA = not applicable

# APPENDIX E
# CASCADE TECHNICAL SERVICES
# PROCESS FLOW DIAGRAM

REVISED CAPITAL INDUSTRIES PLANT 4 STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008



Dry Chemical Storage Area
Drum or diaphragm Pump
Reagent Line
Reagent Container
Bulk Head Fitting
Bulk Head Fitting
Tank Lid
Tank Lid
Reagent Transfer Hose
Reagent Manifold
Mixing Tote
Electric Mixer
Electric Mixer
Water Transfer Hose
Water Manifold
P-9
Bulk Head Fitting
Bulk Head Fitting
Ball Valve
Tote Connection
Ball Valve
P-6
Y Strainer
Injection Pump
Water Source
P-25
Ball Valve
Y Strainer
Up to 10 point Manifold w/Pressure Relief
System Pressure
Ball Valves
Pressure Gauges
Flow Meters
Safety Shower
Side view of Manifold
Direct Push Or Well Connection
Pressure Gauge
Pressure Relief Hose
Injection Hose
5 Gallon bucket or tub
Injection Screen

# APPENDIX F
# CARUS REMEDIATION PERMANGANATE NATURAL OXIDANT DEMAND PROCEDURE BRIEF

REVISED CAPITAL INDUSTRIES PLANT 4 STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

**CARUS**
**REMEDIATION**

# Permanganate Natural Oxidant Demand (PNOD) Procedure and Non-Regulated Soil Submittal Procedure

RemOx® ISCO Reagent

TECHNICAL BRIEF

## PROCEDURE

Carus Corporation follows ASTM Method D7262-10, Test Method A, for permanganate natural oxidant demand (PNOD) analysis. A brief summary of D7262-10 Test Method A follows:

For each soil sample, 600 g of soil are baked at 105°C. The soils are dosed in triplicate at one initial potassium permanganate ($KMnO_4$) level of 100 ml of 20g/L $KMnO_4$ to 50 g of soil for an initial dose of 40 g $KMnO_4$/kg dry soil. The reactor vials are gently inverted. Following 48 hours of reaction time, the liquid portion of the treated sample is analyzed for permanganate residual following method 4500-$KMnO_4$ Potassium Permanganate in Standard Methods for the Examination of Water and Wastewater.

To order a complete copy of the ASTM method, visit http://www.astm.org.

## NON-REGULATED SOIL SUBMITTAL PROCEDURE

Note: This procedure is for soils from areas of the United States for which movement is not restricted under the U.S. Department of Agriculture (USDA).

For each sample location at a remediation site, collect at least 600 grams of soil sample. Two completely filled 250-mL wide mouth glass jars (free of large rocks) with PTFE lined screw caps will provide a sufficient quantity. The ASTM D7262-10 method for PNOD specifies that at least 600 grams soil/aquifer solids be available at the start of testing. Groundwater is not collected for this method.

Fill the containers completely and pack the soil as tightly as possible to eliminate as much entrapped air as possible.

Record the following information on the labels of the sample containers:

Date and time of sampling
Location of the sampling
Initials of the person collecting the sample

Enclose the bottles in bubble wrap or other acceptable packing material to prevent the glass bottles from breaking in transit. Place the samples in a cooler with ice if needed to maintain proper temperature. ASTM D7262-10 specifies the holding time of samples as up to 28 days if held at 4ºC.

The Carus laboratory is closed on weekends and holidays. Samples should be shipped between Monday and Thursday to the address below specify overnight delivery. As part of the Responsible Care® 14001 Plant Security requirements, the following information must be on the outside of the shipping container:

Carus Corporation
Attention: Dylan Kemmerer
1500 Eighth Street
Bldg 45- Customer Service Lab
LaSalle, IL 61301

Also include the name and address of the originator, the contact person and a phone number on the shipping container.

Note: The Carus receiving department will not accept samples without the identifications above.

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# APPENDIX G
# CARUS REMEDIATION REMOX DESK REFERENCE

REVISED CAPITAL INDUSTRIES PLANT 4 STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

# CARUS
REMEDIATION

RemOx® Desk Reference:

RemOx® ISCO Reagent

TECHNICAL BRIEF

## RemOx® S ISCO Reagent ($KMnO_4$) Calculations

### Calculation for Mixing RemOx S Concentrations in One Gallon of Water

| RemOx S % | Relative Density* | Pounds of RemOx S |
|---|---|---|
| 1 | 1.007 | 1/12 |
| 2 | 1.014 | 1/6 |
| 3 | 1.020 | 1/4 |
| 4** | 1.027 | 1/3 |

* Estimated

** Achieving a >4% concentration of RemOx S is difficult and is not recommended unless using heated water.

### Alternative Calculation for Mixing RemOx S Solutions

Calculation: Final volume of RemOx S in gallons x desired RemOx S % x weight of 1 gallon $H_2O$ or 8.345 lbs. = pounds of RemOx S

Example: Need 2,000 gallons of a 2.5% solution
2,000 x 0.025 x 8.345 = 417.25 lbs. RemOx S

## RemOx® L ISCO Reagent ($NaMnO_4$) Calculations

### Diluting RemOx L

Calculation: Total gallons x desired concentration % x relative density of desired concentration in g/mL x weight of 1 gallon of water = pounds of 100% $NaMnO_4$

Example: 2,000 gallons x 0.1 x 1.08 x 8.345 = 1,802.5 lb 100% $NaMnO_4$ or 4,506.3 pounds 40% $NaMnO_4$
Convert from 100% $NaMnO_4$ to 40% $NaMnO_4$ divide by 0.4

### To Convert RemOx L from Pounds to Gallons Divide Pounds by Weight of 1 Gallon of RemOx L

| RemOx L % | Relative Density* | Weight of one Gallon of RemOx L |
|---|---|---|
| 40 | 1.37 | 11.43 |
| 20 | 1.18 | 9.67 |
| 15 | 1.12 | 9.34 |
| 10 | 1.08 | 9.09 |
| 5 | 1.04 | 8.67 |

* Estimated

Note: Calculators are available to assist with diluting RemOx S or RemOx L. Contact Carus Remediation Technologies.

## General RemOx Calculations

### Convert RemOx S to RemOx L

Calculation: Divide RemOx S by 0.4 and multiply by 0.898

Example: What is the equivalent amount of RemOx L for 5,000 pounds of RemOx S?
(5,000/0.4) x 0.898 = 11,225 pounds RemOx L

### Convert RemOx L to RemOx S

Calculation: Divide RemOx L by 0.898 and multiply by 0.4

Example: What is the equivalent amount of RemOx S for 5,000 pounds of RemOx L?
(11,225 x 0.4) / 0.898 = 5,000 pounds RemOx S

CORPORATE HEADQUARTERS | 315 Fifth Street, Peru IL 61354 | Tel + 1.815.223.1500 / 1-800-435-6856 | Fax + 1.815.224.6697 | Web: www.caruscorporation.com | E-Mail: salesmkt@caruscorporation.com
CARUS EUROPE | Parque Empresarial de ASIPO | C/Secundino Roces 3, Planta 1, Oficina 13-14 | 33428 Cayes, Llanera Spain | Tel +34.985.78.55.13 / Fax +34.985.78.55.10

Form# RX 1698

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# CARUS
REMEDIATION

RemOx® Desk Reference:

RemOx® ISCO Reagent

TECHNICAL BRIEF

## Common Contaminants of Cencern Solubility and RemOx Effectiveness

| COC | Solubility mg/L @ 68-77°F | Oxidized by Permanganate |
|---|---|---|
| Vinyl chloride | 1,100 | Yes |
| 1,1 Dichloroethene<br>1,2 tDichloroethene | 400<br>6,300 | Yes |
| Trichloroethene | 1,100 | Yes |
| Tetracholoroethene | 150 | Yes |
| Carbon tetrachloride | 785 | No |
| Methylene chloride | 13,000 | No |
| Benzene | 1,800 | No |
| Toluene | 520 | Yes |
| Ethylbenzene | 187 | Yes |
| Xylenes | 152-157 | Yes |
| Chlorobenzene | 502 | No |
| Dichlorobenzenes | 42-156 | No |
| Trichlorobenzenes | 2.4-52 | No |

| COC | Solubility mg/L @ 68-77°F | Oxidized by Permanganate |
|---|---|---|
| Naphthalene | 25 | Yes |
| Phenanthrene | 0.9 | Yes |
| Pyrene | 0.11-0.18 | Yes |
| Styrene | 300 | Yes |
| 1,4-dioxane | Miscible | Yes |
| Pentachlorophenol | 10-20 | Yes |
| MTBE | 4,800 | Partially |
| Tert-butyl alcohol | Miscible | No |
| GRO | Varied | Partially |
| DRO | Varied | Partially |
| RDX & HMX | 7.6 & 6.6* | Yes |
| TNT &DNT | 115 & 180 | No |
| PCBs | 0.003 -906* | No |

Solubility Reference: Montgomery, John H. (2007). Groundwater Chemicals Desk Reference (4th ed.). Boca Raton, Florida: CRC Press, LLC.

*References available upon request

## Permanganate Color Chart in mg/L

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# APPENDIX H
# CARUS REMEDIATION REMOX ISCO REAGENT RESIDUAL DETERMINATION BRIEF

REVISED CAPITAL INDUSTRIES PLANT 4 STAGE 1 FIELD
IMPLEMENTATION WORK PLAN
West of 4th Group Site
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

**CARUS**
**REMEDIATION**

# RemOx® ISCO Reagent Residual Determination Using the Hach DR 890

## TECHNICAL BRIEF

### OBJECTIVE

This method can be used to determine the residual permanganate in water using standard spectrophotometric methods.

### NOTE

If the instrument is being used for the first time, a calibration curve needs to be stored in the instrument. The absorbance is measured at 520 nm. A minimum of three standards should be used to generate this curve. (See instructions in the DR 890 instruction manual).

### PROCEDURE

1. Obtain a water sample of unknown permanganate concentration and filter through a 0.45 um oxidant-resistant syringe filter (recommended examples are Whatman 0.45 um syringe filters or Millipore Millex GV syringe filters). This is to remove any turbidity and $MnO_2$ that may be present.

2. The sample may need to be diluted at this time. The acceptable range for reading residual permanganate on the DR 890 is approximately 1-50 mg/L. The sample should be diluted with deionized water to read within this range.

3. Enter program number 102 for the stored program on the instrument.

4. Zero the colorimeter using either deionized water or filtered, untreated groundwater. Fill the vial to the 25 mL mark and face the diamond shape on the sample cell towards the keypad. Note: Be sure to wipe the vial so it is clean, free of streaks, and dry. Place the light shield over the sample cell and press zero on the instrument.

5. Fill a second vial to the 25 mL mark with filtered groundwater containing an unknown concentration of permanganate. Note: Be sure to wipe the vial so it is clean, free of streaks, and dry. Place the light shield over the sample cell and press read on the instrument. The program will give the result in mg/L as either $KMnO_4$ or $NaMnO_4$. All Carus rental units read the results as $KMnO_4$. If a dilution was used, multiply the colorimeter reading by the dilution factor.

### CALCULATION

If analyzing for RemOx® L ISCO reagent (sodium permanganate) use the following equation to convert: mg/L $KMnO_4$ X 0.895 = mg/L $NaMnO_4$

### RETURN INFORMATION

Please be sure all vials are empty and clean before shipping the kit back to Carus. No liquids should be shipped. Please send colorimeter back to the address listed below and insure shipment for $1,500. Thank you!

Carus Corporation
Attention: Dylan Kemmerer- Bldg 45
1500 8th Street
LaSalle, IL 61301

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# APPENDIX I
# ANTICIPATED INTERIM ACTION SCHEDULE

REVISED CAPITAL INDUSTRIES PLANT 4 STAGE 1 FIELD IMPLEMENTATION WORK PLAN
West of 4th Group Site
5801 3rd Avenue South
Seattle, Washington

Farallon PN: 457-008

# Appendix I
# Anticipated Interim Action Schedule
# Capital Industries Plant 4
# Seattle, Washington

| | Q3 2017 | | | | | | | Q4 2017 | | | | | | Q1 2018 | | | | | | | Q2 2018 | | | | | | Q3 2018 | | | | | | | Q4 2018 | | | | | | | Q1 2019 | | | | | | Q2 2019 | | | | | | Q3 2019 | | | | | | | Q4 2019 | | | | | | | Q1 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Week Beginning** | 3-Jul-17 | 17-Jul-17 | 31-Jul-17 | 14-Aug-17 | 28-Aug-17 | 11-Sep-17 | 25-Sep-17 | 9-Oct-17 | 23-Oct-17 | 6-Nov-17 | 20-Nov-17 | 4-Dec-17 | 18-Dec-17 | 1-Jan-18 | 15-Jan-18 | 29-Jan-18 | 12-Feb-18 | 26-Feb-18 | 12-Mar-18 | 26-Mar-18 | 9-Apr-18 | 23-Apr-18 | 7-May-18 | 21-May-18 | 4-Jun-18 | 18-Jun-18 | 2-Jul-18 | 16-Jul-18 | 30-Jul-18 | 13-Aug-18 | 27-Aug-18 | 10-Sep-18 | 24-Sep-18 | 8-Oct-18 | 22-Oct-18 | 5-Nov-18 | 19-Nov-18 | 3-Dec-18 | 17-Dec-18 | 31-Dec-18 | 14-Jan-19 | 28-Jan-19 | 11-Feb-19 | 25-Feb-19 | 11-Mar-19 | 25-Mar-19 | 8-Apr-19 | 22-Apr-19 | 6-May-19 | 20-May-19 | 3-Jun-19 | 17-Jun-19 | 1-Jul-19 | 15-Jul-19 | 29-Jul-19 | 12-Aug-19 | 26-Aug-19 | 9-Sep-19 | 23-Sep-19 | 7-Oct-19 | 21-Oct-19 | 4-Nov-19 | 18-Nov-19 | 2-Dec-19 | 16-Dec-19 | 30-Dec-19 | |
| **Project Management** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Project Management | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Interim Action Work Plan** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Draft Work Plan | ■ | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ecology Review | | ■ | ■ | ■ | ■ | * | | | | | | | | ■ | ■ | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AO Amendment/Public Comment Period | | | | | | | **9/29/17 to 10/31/17** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Final Work Plan | | | | | | | | | | | ■ | ■ | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Field Implementation Work Plan** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Draft Work Plan | | | | | | | | | | | | | | | | | ■ | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ecology Review | | | | | | | | | | | | | | | | | | ■ | ■ | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Stage 2 Field Implementation Work Plan [1] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| **Interim Action Field Schedule** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Underground Injection Control Permit | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Install Observation Wells | | | | | | | | | | | | | | | | | | | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Baseline GW Monitoring Event | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stage 1 ISCO Injections | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stage 1 Performance Borings [2] | | | | | | | | | | | | | | | | | | | | | | | | | | | | A | | *B | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stage 1 Performance GW Monitoring | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | * | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stage 2 ISCO Injections | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | ■ | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stage 2 Performance/Confirmation Borings | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ***To be determined based on Stage 1 performance data** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Monthly Performance GW Monitoring | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | * | | * | | | | | | | | | | | | | | | | | | | | |
| Quarterly Performance GW Monitoring | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | * | | | | | | | * | | | | | | | ■ |
| **Interim Action Completion Report** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Draft Completion Report[3] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | |
| Ecology Review | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | |
| Final Completion Report | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | * |
| **Quarterly Progress Reports** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Quarterly Progress Report | | | | | | | ■ | | | | | | | ■ | | | | | | | ■ | | | | | | ■ | | | | | | | ■ | | | | | | | ■ | | | | | | ■ | | | | | | ■ | | | | | | | ■ | | | | | | ■ | ■ |

NOTES:

* denotes project milestone

[1] A Stage 2 Final Field Implementation Work Plan will be submitted to the Washington State Department of Ecology (Ecology) for approval after the performance monitoring results of the Stage 1 injections have been evaluated.

[2] There are two rounds of performance soil sampling following the Stage 1 ISCO Injections. They are referred to as performance monitoring events A and B on this Interim Action Schedule. The actual timing between sampling events will be dependent on groundwater monitoring as indicated in the Work Plan.

[3] The Draft Interim Action Completion Report will be submitted to Ecology for review within 30 to 45 days after receiving data necessary to demonstrate compliance with interim action objectives. For the purposes of this schedule, this submittal is assumed to be 30 days after receipt of the Q4 2019 performance groundwater monitoring event. Groundwater sampling may continue beyond Q4 2019 to confirm the effectiveness of the interim action.