Aspect CONSULTING

July 27, 2017

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
Capital Industries Plant 4 Interim Action Work Plan

Dear Mr. Jones:

Please find enclosed the Capital Industries Plant 4 Interim Action 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,

Aspect consulting, LLC

Dana Cannon

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

Attachments: Capital Industries Plant 4 Interim Action Work Plan

S:\Art Brass Plating 050067\W4 Ecology Correspondence\Cover Letters\CIPlant4_IAWP_072717.docx

FARALLON CONSULTING

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

July 27, 2017

Mr. Ed Jones, Project Manager
Washington State Department of Ecology
3190 160th Avenue Southeast
Bellevue, Washington 98008-5452

BY E-MAIL AND MAIL

**RE: SITE UNIT 2 INTERIM ACTION WORK PLAN
CAPITAL INDUSTRIES PLANT 4 BUILDING
CAPITAL INDUSTRIES, INC., SEATTLE, WASHINGTON
AGREED ORDER NO. DE 10402
FARALLON PN: 457-008**

Dear Mr. Jones:

Farallon Consulting, L.L.C. (Farallon) has prepared an Interim Action Work Plan on behalf of Capital Industries, Inc. (Capital) for the property at 5801 3rd Avenue South in Seattle, Washington (herein referred to as the Capital Site). The proposed interim action will be conducted at the Capital Plant 4 building in accordance with Agreed Order No. DE 10402 entered into by potential liable persons (PLPs) that include Capital; Art Brass Plating, Inc.; Blaser Die Casting Co.; and PSC Environmental Services, LLC; and also with the Washington State Department of Ecology (Ecology) dated April 23, 2014 (Agreed Order). Capital and the other PLPs listed above are referred to collectively as the West of 4th Group. The West of 4th Group site under the Agreed Order consists of Site Unit 1 (SU1) and Site Unit 2 (SU2). The Capital Site is located within SU2.

This letter also includes the Ecology-required response to comments presented in the letter regarding West of 4th Site – Feasibility Study dated June 27, 2017, from Mr. Ed Jones of Ecology to Messrs. Mike Merryfield, Ronald S. Taylor, Kevin Callan, and Andy Maloy of the West of 4th Group, in which Ecology summarizes its position regarding the elimination of the SU2 pilot study and provides an alternative proposal to conduct an interim action at the Capital Plant 4 building while the SU1 pilot studies are being conducted.

INTERIM ACTION VERSUS PILOT STUDY STATUS

In December 2016, Ecology and the West of 4th Group agreed to evaluate the feasibility of select cleanup technologies via bench and/or field-scale pilot testing to reduce the time frame for cleanup and protect the Lower Duwamish Waterway. At that time, the West of 4th Group and Ecology concurred that the pilot study also would have a secondary benefit as a small-scale interim action that would reduce contaminant mass. Between December 2016 and June 2017, the West of 4th Group had numerous internal meetings and met with Ecology on several occasions to reach concurrence on the scope and location for the SU2 pilot study/interim action. During those meetings, the location evolved from:

- Conducting the pilot study in an area near monitoring well CI-14 to;
- Conducting the pilot study north of monitoring well CI-14 along 1st Avenue South to;
- Conducting the pilot study near monitoring well CG-141 to;
- Conducting the pilot study near monitoring well CI-15; and to
- Conducting the pilot study in the areas of either monitoring well CG-141 or monitoring well CI-15.

Each location involved trade-offs between logistical and access difficulty, benefit as an interim action, and benefit as a pilot study for future implementation of the final remedy.

The selection of a location for the SU2 pilot study was further complicated by unresolved technical issues related to the degree to which the vinyl chloride concentrations in groundwater at the area near 1st Avenue South is comingled from multiple sources. In June 2017, during the most recent meeting between the West of 4th Group and Ecology, implementation of an interim action at the Capital Plant 4 building was suggested as a less than optimal alternative to implementing a pilot study/interim action near 1st Avenue South. It is the opinion of the West of 4th Group that the benefits of implementing an interim action at the Capital Plant 4 building outweigh the benefits of an unsatisfactory compromise to a pilot study near 1st Avenue South that would no longer meet the original pilot study objectives, and would require further protracted negotiations to reach concurrence. The basis for this opinion is summarized below:

- The West of 4th Group understand that reduction of high vinyl chloride concentrations at the areas of monitoring wells CG-141and CI-15 are a higher priority to Ecology than the tetrachloroethene/trichloroethene plume at the Capital Plant 4 building. However, the groundwater data at the locations of monitoring wells CG-141 and CI-15 indicate that vinyl chloride biodegradation is occurring based on elevated ethene and ethane concentrations. Monitoring wells down-gradient have historically also had low concentrations of vinyl chloride indicating that an imminent threat to the Lower Duwamish Waterway does not exist, hence Ecology not requiring an interim action during the Remedial Investigation/Feasibility Study phases of work. On this basis, delaying cleanup at the areas of monitoring wells CG-141 and CI-15 does not pose a risk to human health or the environment.

- The West of 4th Group has also been exploring possible additional investigation to resolve data gaps that will refine the conceptual site model for contaminant fate and transport near monitoring wells CG-141, CI-15, and CG-140. The objective of the additional investigation would be to resolve technical data gaps that contributed to the difficulty in selecting a location for the pilot test. Resolving these issues would likely provide a better understanding of the subsurface conditions and support an appropriate cleanup approach.
- The tetrachloroethene/trichloroethene plume at the Capital Plant 4 building is not an imminent threat to the Lower Duwamish Waterway, but the contamination is present in the Water Table Zone, which is not highly conducive to reductive dechlorination and will not readily naturally attenuate without further action. Consequently, the Water Table Interval contamination represents an ongoing vapor intrusion risk. Vapor intrusion risk and mitigation measures at the neighboring Pacific Food Systems building may be eliminated by conducting the interim action now.

In summary, replacing an SU2 pilot study near 1st Avenue South with an interim action at the Capital Plant 4 building will not affect evaluation of alternatives presented in the SU2 Feasibility Study Report. Further, the vinyl chloride at the areas of monitoring wells CG-141 and CI-15 is being biodegraded and does not represent an immediate threat to human health or the environment. The injection work that will be conducted during the SU1 pilot study and the proposed interim action at the Capital Plant 4 building will also provide information required to refine the understanding of the application of in situ chemical reduction technologies via direct injection. The SU2 PLPs believe that the interim action at the Capital Plant 4 building should be completed concurrently with the SU1 pilot studies. The West of 4th PLPs also will continue work voluntarily on refining the conceptual site model for the vinyl chloride concentrations in the areas of monitoring wells CG-141, CI-15, and CG-140. Understanding this area's source and fate and transport will result in a more effective cleanup approach for concurrence by West of 4th PLPs and Ecology.

CLOSING

Farallon trusts that this quarterly progress report provides sufficient information for Ecology needs. If you have questions regarding this project, please contact the undersigned at (425) 295-0800.

Sincerely,

Farallon Consulting, L.L.C.

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

cc: Ron Taylor, Capital Industries, Inc. (by e-mail)
Donald Verfurth, Gordon and Rees, L.L.P. (by e-mail)

E-mail with link to electronic copy on project website:
Janet Knox, Pacific Groundwater Group
Dana Cannon, Aspect Consulting
Bill Carroll, Arrow Environmental
Bill Beck, Stericycle Environmental Solutions

JK/tlc

CAPITAL INDUSTRIES PLANT 4 INTERIM ACTION WORK PLAN

West of 4th Group Site
Capital Industries, Inc.
5815 4th 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

July 27, 2017

Prepared by:

Jennifer L. Moore
Associate Scientist

Matthew Nusenow, P.E.
Senior Engineer

Reviewed by:

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

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FIGURES

TABLES

APPENDIX

ACRONYMNS AND ABBREVIATIONS

Aspect	Aspect Consulting
bgs	below ground surface
CI	Capital Industries, Inc.
cis-1,2-DCE	cis-1,2-dichloroethene
CVOCs	chlorinated volatile organic compounds
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
Farallon	Farallon Consulting, L.L.C.
ISCO	in-situ chemical oxidation
PCE	tetrachloroethene
PCULs	preliminary cleanup levels
PGG	Pacific Groundwater Group
PLP	potentially liable parties
RI	Remedial Investigation
ROI	radius of influence
SEPA	State Environmental Policy Act
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 4th Site Unit 2 Feasibility Study, Seattle, Washington* dated August 11, 2016, prepared by 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 PSC Environmental Services, LLC
Work Plan	Draft *Conceptual Interim Action Work Plan, Site Unit 2, Seattle, Washington* dated July 27, 2017, prepared by Farallon Consulting, L.L.C. (this document)

1.0 INTRODUCTION

Farallon Consulting, L.L.C. (Farallon) has prepared this Interim Action 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 (PLPs) 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).

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, and the Washington State Model Toxics Control Act Cleanup Regulation as established in Chapter 173-340 of the Washington Administrative Code.

1.1 OBJECTIVE

The purpose of the Work Plan is to provide the general conceptual overview and framework for implementation of an 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) (West of Fourth Group and PGG 2016) (SU2 FS Report). The ISCO technology that will be used includes direct injection of potassium permanganate into the subsurface to treat shallow soil and groundwater. The objectives of the interim action are tied to the remedial action objectives for the Site as described in the SU2 FS Report and include:

- Reduce chlorinated volatile organic compound (CVOC) concentrations 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;

[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.

- Reduce CVOC concentrations in shallow groundwater that allegedly originated from CI Plant 4 to concentrations less than the PCULs for the Site; and
- Reduce risk of recontamination of soil and/or shallow groundwater beneath CI Plant 4 from up-gradient sources off the CI property to the extent practicable.

The Work Plan provides sufficient detail regarding the interim action for Ecology to approve proceeding under Agreed Order No. DE 10402. A detailed Field Implementation Work Plan that includes a Health and Safety Plan, Sampling and Analysis Plan, and Quality Assurance Performance Plan, as described in Section 6.0, will be prepared following approval of this conceptual Work Plan.

1.2 ORGANIZATION

This Work Plan summarizes pertinent background information and provides context and a general framework for 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 relevant investigations and a description of the constituents of concern that will be targeted during the interim action;
- **Section 3, Preliminary Cleanup Levels,** presents the revised preliminary cleanup levels for the Site that will be used to evaluate whether the remedial technology can meet the cleanup objectives;
- **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, Proposed Interim Action,** presents a description of the proposed interim action, including a discussion of the remedial technology, permitting, the interim action approach, and the performance and confirmation monitoring programs;

- **Section 6, Interim Action Documentation,** presents a description of documents that will be generated to govern and report on 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; and
- **Section 8, References,** lists the documents cited in this Work Plan.

2.0 BACKGROUND

The following section presents background information, including a summary of relevant investigations and a description of the constituents of concern that will be targeted during the interim action.

2.1 PREVIOUS INVESTIGATIONS AT CI PLANT 4

Former operations at the CI property 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 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 that was used in CI Plant 4 from approximately 1987 to 1992 was removed in 1993. The hot solvent degreaser and associated drummed chemical storage areas formerly were located in the southwestern corner of CI Plant 4.

During subsurface investigations conducted by Farallon (2012) at CI Plant 4 during the Remedial Investigation (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 COCs detected in groundwater samples collected from the Water Table and/or Shallow Intervals (i.e., at depths of from 0 to 20 feet below ground surface [bgs] and from 20 to 40 feet bgs, respectively) near the suspected source areas previously identified at the CI property suggest there may be areas where concentrations of COCs 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 of the Site previously described in the technical memorandum regarding Revised Data Gap Memorandum for Site Unit 2, W4 Joint Deliverable, Seattle, Washington dated March 2, 2015, prepared by 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 also were detected 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 unit area 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.

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 1; Figure 3A). The maximum PCE concentration detected was 0.64 milligram per kilogram at boring P4-B6 at the southeastern portion of CI Plant 4, east of the former degreasing unit.

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 1; Figure 3B). The maximum TCE concentration detected was 0.48 milligram per kilogram at boring P4-B7 at the central portion of CI Plant 4.

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

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

The soil analytical results indicate that the highest concentrations of CVOCs are present immediately beneath the 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 and post-remedial investigation 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 2, Figure 4). PCE and TCE were not detected in the Shallow or Intermediate Groundwater Intervals (i.e., at depths of from 20 to 40 feet bgs and greater than 40 feet bgs, respectively), indicating the release(s) of PCE and TCE that did occur were of insufficient mass and/or volume to affect deeper groundwater.

Sufficient data had been collected at CI Plant 4 to evaluate potential cleanup technologies for soil and groundwater in the SU2 FS Report. The potential active cleanup technologies evaluated and the media potentially remediated included:

- 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 the ability to implement the technology with minimal interference with operations at CI Plant 4, and ISCO's ability to rapidly treat the low levels of CVOCs in soil and groundwater (West of Fourth Group and PGG 2016).

2.2 CONSTITUENTS OF CONCERN FOR INTERIM ACTION

The CVOCs that are constituents of concern for soil include PCE and TCE. These CVOCs are a current and future risk to the soil-to-groundwater and soil-to-indoor air pathways. The CVOCs that are constituents of concern for groundwater in the Water Table Interval include PCE and TCE. These CVOCs are a current and future risk to the groundwater-to-surface water and groundwater-to-indoor air pathways. Further, PCE and TCE have the potential to affect the Shallow Interval where anaerobic conditions exist and reductive dechlorination to vinyl chloride can occur. Elimination 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 established in the technical memorandum regarding Revised Preliminary Cleanup Standards, W4 Joint Deliverable, Seattle, Washington dated September 12, 2014, from Farallon to Mr. Ed Jones of Ecology (Farallon 2014). 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 3 of this Work Plan.

4.0 CONCEPTUAL SITE MODEL

The following section presents a summary of the conceptual site model elements pertinent to the ISCO injection work 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 between 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 PLPs for the Site refer to standardized hydrogeologic units in each of the documents corresponding to the lithologic units described above (Aspect Consulting [Aspect] 2014). These hydrogeologic units are:

- Water Table Interval: The Water Table Interval extends to a depth of up to 20 feet bgs;
- Shallow Interval: The Shallow Interval ranges in depth from 20 to 40 feet bgs; and
- Intermediate Interval: The Intermediate Interval 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 the remedial investigation reports for Art Brass Plating, Inc. (Aspect 2012) and CI (Farallon 2012). Water levels at the Site are tidally influenced by the Puget

Sound. This tidal influence is demonstrated in localized, transient flow reversals similar to those observed at other sites in the vicinity of 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 subsections 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 present in an area extending from the east-central portion to the south-southwestern portion of CI Plant 4 (Figures 3A through 3C). The highest concentration of 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).

4.3.2 Soil

The highest concentrations of PCE and TCE observed in the borings advanced at and proximate to CI Plant 4 occurred at a depth of approximately 1 foot bgs. Additional soil samples with concentrations exceeding the PCULs were collected in the silty material at borings P4-B1, P4-B4 through P4-B8, and P4-B14, which are predominately on the southeastern portion of CI Plant 4 and in the northern right-of-way of South Fidalgo Street. The vertical extent of soil contamination exceeding the 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 unit that was present on the southern portion of CI Plant 4. CVOCs in groundwater within the Water Table, Shallow, and Intermediate Intervals, including PCE, TCE, and vinyl chloride, migrate to the southwest in SU2, towards Slip 2 at the Lower Duwamish Waterway (Aspect 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 recontaminate 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. The Water Table Interval is overall the least reducing of the groundwater intervals, bordering on aerobic to anoxic conditions, whereas reducing conditions increase with depth (Farallon 2017). Table 4 presents the geochemical data for monitoring wells MW-6 and MW-7 that are within the interim action area and will be monitored for changes in geochemistry resulting from the ISCO injections.

5.0 PROPOSED INTERIM ACTION

This section presents a description of the interim action, including a discussion of the remedial technology, permitting, the interim action approach, and the performance and confirmation monitoring programs.

5.1 REMEDIAL TECHNOLOGY

The remedial technology proposed for this interim action is ISCO using potassium permanganate ($KMnO_4$). Potassium permanganate is a single component chemical oxidant that does not require activation using other compounds or pH adjustment. A general overview of ISCO is provided in Appendix A, *A Citizen's Guide to In Situ Chemical Oxidation* prepared by EPA.

Potassium permanganate will be mixed with water in a 3 percent solution and injected into contaminated soil and groundwater, causing a chemical reaction that will destroy contaminants and produce harmless byproducts. The 3 percent solution is anticipated to be sufficient to achieve the PCULs based on:

- Low concentrations of CVOCs in soil and Water Table Interval groundwater; and
- Suspected low oxidant demand.

The potential oxidant demand is suspected to be low based on historical groundwater CVOC and geochemical data for monitoring wells proximate to CI Plants 4 and 2 (Tables 2 and 4). The CVOC data indicate that the Water Table Interval is aerobic to anoxic. Reductive dechlorination of the CVOCs is minimal, with electron acceptors such as nitrate, ferric iron, manganese (IV), and sulfate being more prevalent than their reduced equivalents. Observations of the soil matrix during RI work have not indicated the presence of visible organic materials, which would also affect the oxidant demand. While the dosing concentration of 3 percent cannot be fully substantiated without bench scale testing, the initial phase of ISCO application described herein is anticipated to provide sufficient understanding of the oxidant demand to successfully apply ISCO throughout CI Plant 4 and achieve the interim action objectives.

The oxidation of TCE by potassium permanganate is described by the following reaction:

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

The oxidation of PCE and vinyl chloride will be similar, with varying amounts of the byproducts in the above reaction being produced.

Injection of potassium permanganate will be implemented through direct-push ISCO injection points. At this time, the radius of influence (ROI) is anticipated to range from 5 to 20 feet and will be dependent on the soil types within the vadose and saturated zones, as well as the injection pressures that can be applied. No pilot testing has been performed for injection work; therefore, the ISCO injections for the interim action will be phased to first evaluate the ROI and concentration of potassium permanganate that will be effective prior to conducting a second series of injections. The proposed injection locations are depicted on Figure 5. Effectiveness of ISCO will be evaluated in accordance with the monitoring program described in Section 5.6, Monitoring.

5.2 BASELINE GROUNDWATER SAMPLING

Baseline groundwater samples will be collected from Water Table Interval monitoring wells MW-6 and MW-7. The groundwater sampling will be conducted in general accordance with 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 to Mr. Ed Jones of Ecology (PGG 2017). The groundwater samples will be submitted to a Washington-accredited laboratory for analysis for CVOCs by EPA Method 8260C. Additional geochemical parameters that will be directly measured during sample collection using field instrumentation will include temperature, pH, dissolved oxygen, oxidation-reduction potential, and specific conductance.

5.3 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. Farallon will also prepare a State Environmental Policy Act (SEPA) checklist for submittal to Ecology prior to implementation of the interim action.

5.4 UTILITY CLEARANCE

Public and private utility locating services will be contracted to clear the proposed ISCO injection and confirmation boring locations prior to drilling activities. Information pertaining to the locations of subsurface utilities will be documented for future reference. Drilling locations may be modified as necessary during field activities based on access considerations and the locations of utilities and other features.

5.5 INTERIM ACTION APPROACH

Typical ROIs for injections range from 2.5 feet for tight clays to 25 feet in permeable saturated soils (Interstate Technology Regulatory Council 2005). Subsurface environments are rarely homogeneous and isotropic, and the injection design must also take this into account. Pilot testing is typically necessary to understand the variation in ROI and enable effective distribution of the oxidant throughout the subsurface. The potassium permanganate will be injected in two stages. Stage 1 is intended to evaluate the logistics of injecting into the vadose zone and the Water Table Interval prior to implementing the full-scale interim action. Distribution of potassium permanganate will be verified by drilling performance borings to visually confirm the presence of potassium permanganate at varying distances and directions from the Stage 1 ISCO injection points. Stage 1 performance monitoring also will include a second series of performance sampling to evaluate when the potassium permanganate is expended and the post-injection CVOC concentrations in soil and groundwater. The two performance sampling events will provide data on the ROI/distribution and dosing to inform any necessary changes to the Stage 2 phase of the interim action. Stage 2 is the full-scale implementation of the interim action. Stage 2 injections will target soil and Water Table Interval groundwater with ISCO. Performance and/or confirmation soil and groundwater sampling will be conducted to evaluate the effectiveness of the full-scale ISCO injections.

Additional stages of ISCO injection may be required to achieve the interim action objectives based on the performance and confirmation monitoring results obtained after completion of Stages 1 and 2.

The proposed injection locations are depicted on Figure 5. The conceptual layout at this time includes a grid pattern throughout CI Plant 4 that is currently on 20-foot centers. The results of the Stage 1 pilot testing described in Section 5.5.1 will be used to refine the spacing for borings focused on treatment of CVOCs in the vadose zone and saturated zone.

5.5.1 Stage 1 - Pilot Testing

Stage 1 will be conducted by advancing three ISCO injection points to evaluate the ROI in:

- The silty sand in the upper portion of the vadose zone at ISCO injection location B3;
- The vadose zone where the highest concentrations of PCE and TCE are present in the silt with sand layer at approximately 1 foot bgs and extending to a depth of approximately 6 feet bgs at ISCO injection location F5; and
- The Water Table Interval and extending up into the vadose zone at ISCO injection location E5.

Injection pressure, flow, and volume will be monitored throughout the injection. Sudden changes in these parameters usually indicate the injected materials have found a path of less resistance and are perhaps surfacing.

Performance borings will be advanced after Stage 1 has been completed, to assess the effectiveness of the ISCO injections under these three scenarios. Details of the performance monitoring are presented in Section 5.6, Monitoring. The performance monitoring will provide data on the ROI, oxidant demand/lifespan in the subsurface, and whether a 3 percent concentration of potassium permanganate is adequate to overcome the natural oxidant demand and reduce concentrations of the CVOCs to less than the PCULs for soil and groundwater. The groundwater data will also be used to assess the potential for rebound of CVOCs following the initial injection event.

5.5.2 Stage 2 – Full-Scale Implementation

For the purpose of this Work Plan, it is assumed that a 20-foot ROI can be achieved. Based on the assumed ROI, 23 injection points will be necessary to treat the CVOC-affected area at CI Plant 4 (Figure 5). The full-scale injection details regarding the potassium permanganate concentration and number of injection points will be based on performance data collected during Stage 1. The final ROI may vary depending on the target injection zone (i.e., vadose versus saturated) and will be adjusted accordingly to achieve the interim action objectives.

Following the initial full-scale injection event, performance sampling will be conducted as described in Section 5.6, Monitoring. The time frame for conducting the sampling will be based on the Stage 1 pilot testing results, which provide an estimate of the potassium permanganate lifespan in the subsurface. The sampling will include advancing direct-push borings to evaluate CVOC concentrations in soil and the ROI.

Groundwater will also be evaluated as described in Section 5.6, Monitoring. Following treatment, if CVOC concentrations in groundwater begin to rebound, supplemental ISCO applications may be necessary to achieve the interim action objectives. CVOC concentrations will rebound if the chemical oxidant does not come into direct contact with the affected soil that is the source of the dissolved-phase CVOCs in groundwater, or if the chemical oxidant is expended before all the contamination is treated. The potential for rebound of CVOCs may take several weeks or months to evaluate, depending on the lifespan of the potassium permanganate in the subsurface and the rate of dissolution from the affected soil to groundwater.

The soil and groundwater performance monitoring data will be used to evaluate whether additional ISCO injection events are necessary to meet the interim action objectives. It is likely that additional events will be necessary; however, the areas containing residual CVOCs that exceed the PCULs for soil are expected to become progressively smaller.

5.6 MONITORING

The effectiveness of the ISCO injections will be evaluated through:

- Assessment of the physical distribution of the potassium permanganate in the subsurface by advancing performance borings within the anticipated ROI of the ISCO injections;
- Advancement of performance and confirmation borings near previous soil borings P4-B1 through P4-B9 to confirm that concentrations of CVOCs have been reduced to concentrations less than the PCULs protective of air and surface water quality. If the data from the borings proximate to existing borings confirm that CVOC concentrations are less

than the PCULs, supplemental confirmation soil borings will be advanced in other areas of CI Plant 4 to confirm the soil cleanup; and

- Monitoring groundwater in Water Table Interval monitoring wells MW-6 and MW-7 to assess whether concentrations of CVOCs have been reduced to concentrations less than the applicable PCULs and whether rebound occurs, indicating that the CVOCs in soil that are affecting groundwater have not been fully treated.

Farallon will contract with a drilling company that will advance performance and confirmation borings using a limited-access direct-push drill rig. Soil cores will be collected continuously from approximately 0 to 25 feet bgs. Soil samples will be collected from depths at which historical soil sampling at CI Plant 4 indicated CVOCs exceeding the PCULs existed. Upon completion, the borings will be backfilled with bentonite grout to approximately 1 foot from the ground surface to mitigate settling, and patched with concrete at the ground surface to match the existing grade. The bentonite grout will mitigate the potential for surfacing of future ISCO injections that may be required and also eliminate preferential pathways at the potential locations of future ISCO injections.

Farallon will monitor the effectiveness of the Stage 2 ISCO injections for groundwater treatment at Water Table Interval monitoring wells MW-6 and MW-7 monthly for a period of 3 months. The results of the initial monitoring will be evaluated to determine whether additional ISCO injections targeting the Water Table Interval are necessary to meet the interim action objectives, or whether the monitoring frequency can be decreased to monitor attenuation of CVOCs. The monitoring work will be conducted as described in the sections herein.

5.6.1 Stage 1 ISCO Performance Monitoring

Performance monitoring for Stage 1 injections will be accomplished through advancement of post-injection performance borings within the assumed ROI of 20 feet to visually observe the distribution of potassium permanganate. Potassium permanganate 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. Performance borings will be advanced the same day or the day following the Stage 1 ISCO injections.

Three performance borings will be drilled around each Stage 1 ISCO injection point in a triangular configuration at various distances and directions from the injection point to assess the distribution of potassium permanganate. 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 and to the total depth of the ISCO injection point to assess the actual injection radius of each pilot test injection location and the distribution of the potassium permanganate within the soil matrix. These data will be used to adjust spacing between injection points and vertical injection volume for subsequent injection points, and possibly the method of ISCO delivery, to maximize distribution in the soil matrix.

A second series of performance monitoring borings will be advanced within 2 weeks of the injection event to evaluate the effect of the ISCO on CVOC concentrations in soil within the ROI established during the initial performance monitoring drilling event described above. Visual observations of whether the potassium permanganate persists will be made. If evidence is discovered that the potassium permanganate persists, further sampling will be discontinued for a period of 2 weeks to allow more time for the potassium permanganate to react. If the potassium permanganate appears expended, soil samples will be collected at depths where previous sampling indicated CVOCs were detected, and submitted to the analytical laboratory for analysis for CVOCs by EPA Method 8260C. The results will be used to evaluate whether the initial 3 percent concentration of potassium permanganate is sufficient to overcome the natural oxidant demand of the soil matrix and also reduce CVOC concentrations to less than the PCULs.

Performance monitoring in groundwater within the Water Table Interval will be conducted within 2 weeks of the injection event to evaluate the effect of the ISCO injection on CVOC concentrations in groundwater. Groundwater samples collected during the post-Stage 1 performance monitoring event will be analyzed for CVOCs by EPA Method 8260C.

The concentration of potassium permanganate solution that will be used for the Stage 2 ISCO injections will be adjusted based on the Stage 1 performance sampling data.

5.6.2 Stage 2 ISCO Performance Monitoring and Confirmation Sampling

Stage 2 ISCO compliance monitoring will include soil and groundwater sampling to evaluate the effectiveness of the ISCO injections on meeting the interim action objectives. Performance soil sampling conducted post Stage-2 ISCO injections may be used as confirmation sampling data if the analytical results indicate the PCULs have been achieved within the grid area.

Performance soil sampling will be conducted using direct-push drilling once the potassium permanganate is expended. The time frame for when the oxidant will likely be expended will be based on the results of the Stage 1 pilot testing and adjusted accordingly if the concentration of potassium permanganate is altered for the Stage 2 injection work. A grid will be established within the CI Plant 4 injection area based on the ROI established during the Stage 1 pilot testing. At this time one boring per grid, which may be modified due to areas within CI Plant 4 that cannot be readily accessed, is presumed to be sufficient to evaluate the ISCO effectiveness. The initial performance monitoring will be limited to locations in the southeastern corner of CI Plant 4 where the highest concentrations of CVOCs in shallow soil have been documented. This area will be used to evaluate whether the PCULs have been obtained or whether additional ISCO injection work is required.

At this time, up to six performance sampling borings are planned to be advanced to depths of up to 10 feet bgs to evaluate CVOC concentrations in soil. Continuous soil cores will be collected and soil samples will be collected for laboratory analysis at depths of 1, 3, 5, 7, and 10 feet bgs. All soil samples will be submitted to the analytical laboratory for analysis for CVOCs by EPA Method 8260C. The results of the initial performance monitoring results will be used to evaluate whether additional ISCO injection is required or whether confirmation soil sampling throughout the affected areas of CI Plant 4 can be conducted. The soil sampling details will be presented in the Field Implementation Work Plan.

If confirmation soil sampling is warranted, direct-push borings will be advanced throughout the remaining grid locations within CI Plant 4 following the same sampling intervals identified above. The confirmation soil sampling work will be confirmed with Ecology following receipt of the results of the performance soil sampling. The performance soil sampling work will also be used to evaluate the scope of future ISCO injections, which will also be presented to Ecology for discussion prior to implementing the injection work.

5.6.3 Groundwater Monitoring

Monthly post-injection groundwater sampling will be conducted for the first 3 months and quarterly for the first year at Water Table monitoring wells MW-6 and MW-7. Whether groundwater sampling is necessary for longer than 1 year following the final ISCO injections will be evaluated based on evaluation of the initial year of sampling data. The groundwater sampling will be conducted in general accordance with standard procedures cited in the technical memorandum regarding FINAL West of 4th Groundwater Monitoring Program Plan 2017 through Draft Cleanup Action Plan (PGG 2017), with the ultimate goal of reducing CVOC concentrations in the Water Table Interval to less than the applicable PCULs. The groundwater samples will be submitted to a Washington-accredited laboratory for analysis for CVOCs by EPA Method 8260C.

Additional geochemical parameters that will be directly measured during sample collection using field instrumentation will include temperature, pH, dissolved oxygen, oxidation-reduction potential, and specific conductance. Additionally, monitoring wells will be sampled to confirm oxidant distribution. Potassium permanganate can be detected in groundwater by its purple color. If groundwater in Water Table Interval monitoring wells MW-6 and/or MW-7 is purple, the well will not be sampled until the oxidant is expended. Groundwater samples collected while potassium permanganate is present would not be representative for performance monitoring purposes.

6.0 INTERIM ACTION DOCUMENTATION

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

6.1 PROJECT DOCUMENTS AND REPORTING

6.1.1 Field Implementation Work Plan

A Field Implementation Work Plan for the interim action will be submitted to Ecology following Ecology approval of this Work Plan in accordance with the schedule presented in Section 7.0, Schedule and Reporting. The Field Implementation Work Plan will provide additional details regarding implementation of the interim action, including the final ISCO injection locations, ISCO injection design criteria, performance monitoring details, criteria for evaluating effectiveness of the interim action, and reporting requirements based on comments from Ecology regarding this Work Plan. The Field Implementation Work Plan will also include the following supporting documents.

6.1.1.1 Sampling and Analysis Plan

The Field Implementation Work Plan will include a Sampling and Analysis Plan to guide the sampling efforts associated with the interim action. The Sampling and Analysis Plan will include a discussion of sample locations and frequency to establish baseline groundwater conditions prior to the interim action and monitor the effectiveness of the interim action for up to 1 year following injection of the potassium permanganate.

The Sampling and Analysis Plan will include standard operating procedures related to the specific field tasks that will be performed during the interim action. These standard operating procedures may include field sampling and documentation, soil sampling, groundwater sampling, and waste management.

6.1.1.2 Quality Assurance Project Plan

The Field Implementation Work Plan will include a Quality Assurance Project Plan to assess the quality and reproducibility of analytical data generated in association with the interim action. The Quality Assurance Project Plan will also discuss quality assurance/quality control samples that will be collected to support the interim action.

6.1.1.3 Health and Safety Plan

The Field Implementation Work Plan will include a Health and Safety Plan required for all field activities in accordance with Section 810 of Chapter 173-340 of the Washington Administrative Code. The Health and Safety Plan 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).

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 performance monitoring results as the interim action progresses. If necessary, more-frequent progress reporting via electronic mailing or meetings with Ecology will be conducted to refine the scope of work based on performance monitoring data for the interim action.

6.1.3 Interim Action Completion Report

An Interim Action Completion Report will be submitted to Ecology following the conclusion of the interim action, and will include a summary of the overall interim action results and conclusions. The Interim Action Completion Report will summarize the effectiveness of ISCO in reducing CVOC concentrations in soil and groundwater and whether further action is required during the cleanup action.

7.0 SCHEDULE AND REPORTING

This section summarizes the schedule for implementation of the interim action and associated reporting deliverables that will be produced. The milestones associated with implementation of the interim action and the potential schedule to achieve those milestones are provided below.

Deliverables	**Anticipated Schedule**
Submittal of Work Plan	Week of July 24, 2017
Submittal of Field Implementation Work Plan	Within 45 days of approval of the conceptual approach described in the Work Plan
Submittal of Quarterly Progress Reports	Each quarter following implementation of the interim action
Submittal of Interim Action Completion Report	Within 30 days following receipt of the final performance groundwater monitoring sampling event results for the interim action

Field Work	**Anticipated Schedule**
Permits and SEPA Checklist	Initiated upon Ecology approval of the Work Plan
Baseline Groundwater Monitoring Event	Within 2 weeks prior to Stage 1 ISCO injections
Stage 1 ISCO Injections	To be scheduled upon Ecology approval of the Field Implementation Work Plan and the SEPA Checklist, receipt of UIC permit, and review of the baseline groundwater monitoring event

Advancement of Performance Borings	The first round of Stage 1 performance borings will be advanced immediately following the Stage 1 ISCO injections for visual observations of the ISCO injection radius. A second round of performance borings will be advanced 2 weeks after the Stage 1 injection for visual observations of the persistence of the potassium permanganate, and to assess CVOC concentrations in soil proximate to the Stage 1 injection locations if the potassium permanganate has been expended. This schedule will be modified accordingly if evidence of potassium permanganate persists.
Stage 2 ISCO Injections	Within 2 weeks of review of performance boring data and review/comments from Ecology regarding modifications that deviate from this Work Plan and/or the Field Implementation Work Plan
Advancement of Stage 2 Performance and/or Confirmation Borings	To be determined based on Stage 1 pilot study data
Monthly Performance Groundwater Monitoring	Monthly for 3 months following completion of the full-scale Stage 2 ISCO injections
Quarterly Performance Groundwater Monitoring	Quarterly for up to 1 year following completion of the full-scale Stage 2 ISCO injections

8.0 REFERENCES

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______. 2014. Technical Memorandum Regarding Revised Preliminary Cleanup Standards, W4 Joint Deliverable, Seattle, Washington. From Farallon. To Ed Jones, Washington State Department of Ecology. September 12.

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Interstate Technology Regulatory Council. 2005. *Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater*. Second Edition. January.

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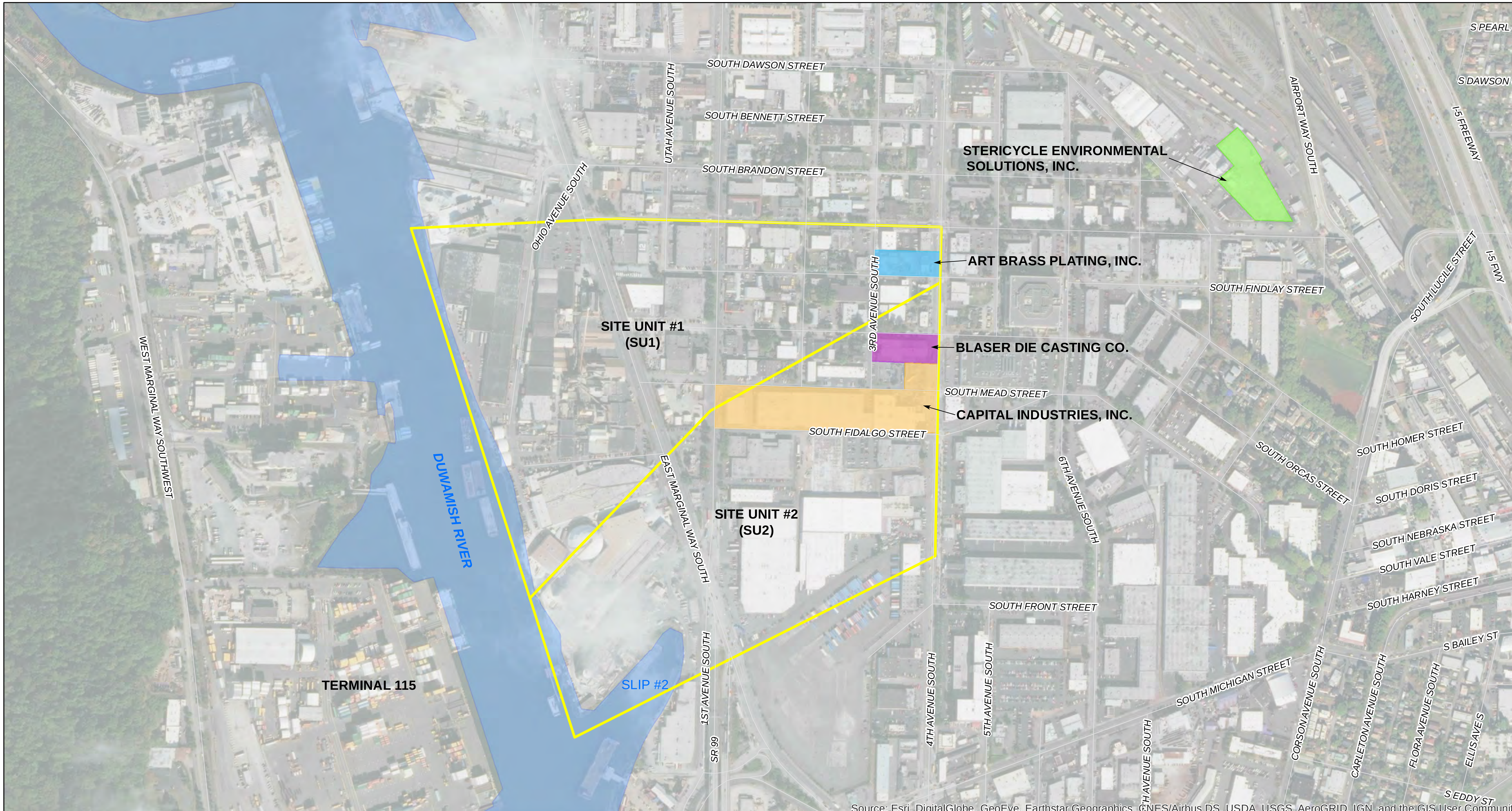
Joint Deliverable, Agreed Order No. DE 10402. From Janet Knox. To Ed Jones, Washington State Department of Ecology. March 21.

West of Fourth Group and Pacific Groundwater Group (West of Fourth Group and PGG). 2016. *West of 4th Site Unit 2 Feasibility Study, Seattle, Washington*. August 11.

FIGURES

INTERIM ACTION WORK PLAN
Site Unit 2
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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Washington
Issaquah | Bellingham | Seattle

Oregon
Portland | Bend | Baker City

California
Oakland | Sacramento | Irvine

FIGURE 1

SITE DIAGRAM
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5815 4TH AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: jjones | Checked By: JK | Date: 7/12/2017 | Disc Reference:

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LEGEND

BUILDINGS

WATER TABLE INTERVAL MONITORING WELL

SHALLOW INTERVAL MONITORING WELL

INTERMEDIATE INTERVAL MONITORING WELL

SITE UNIT BOUNDARY

DRAFT

N

0 40 80

SCALE IN FEET

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Oregon
Portland | Bend | Baker City

California
Oakland | Sacramento | Irvine

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FIGURE 2

PROPERTY DIAGRAM
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5815 4TH AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: jjones | Checked By: JK | Date: 7/27/2017 | Disc Reference:

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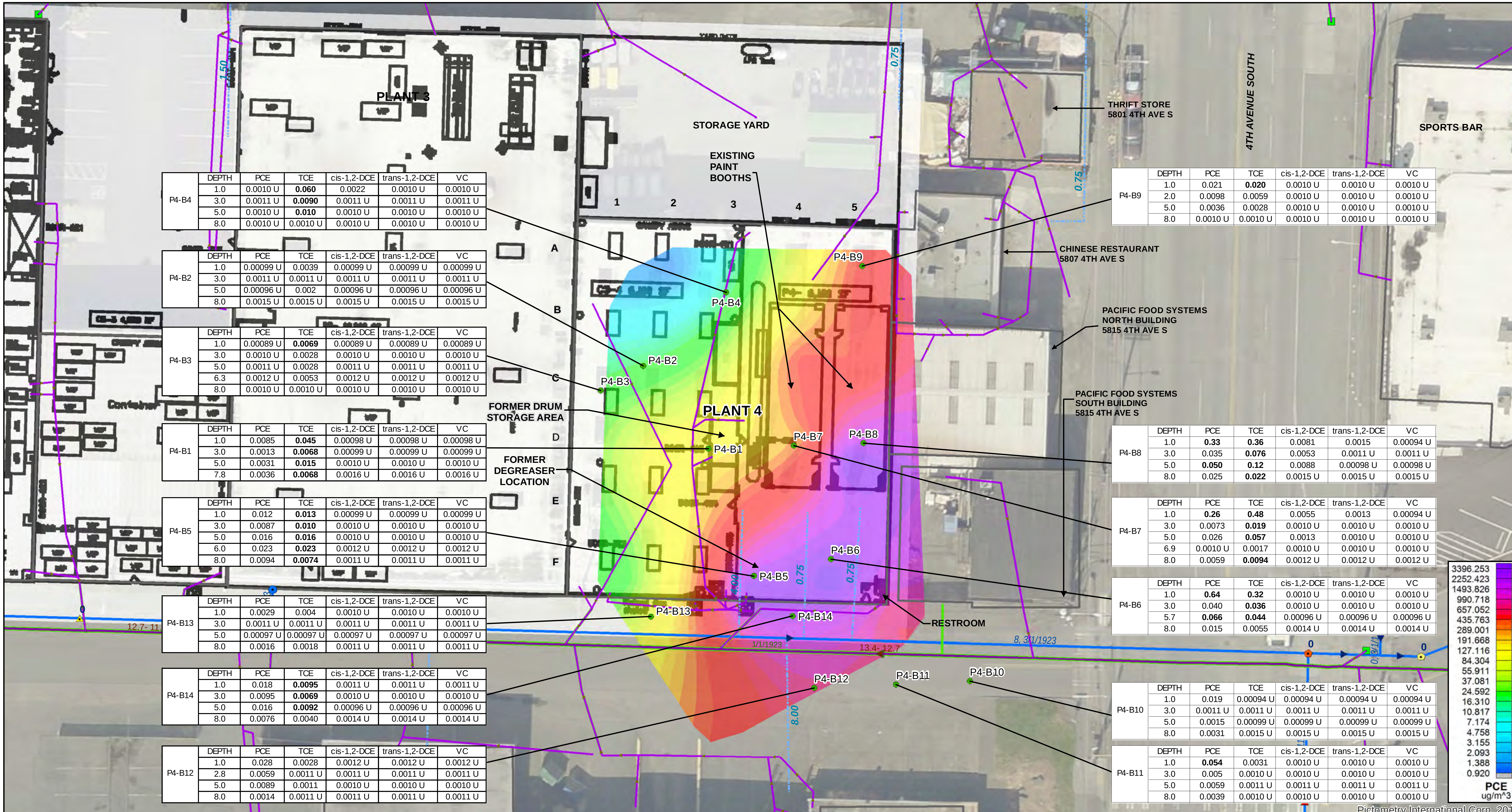

P4-B4

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

P4-B2

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

P4-B3

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

P4-B1

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

P4-B5

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

P4-B13

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

P4-B14

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

P4-B12

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

P4-B9

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

P4-B8

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

P4-B7

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

P4-B6

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

P4-B10

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

P4-B11

DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
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

DRAFT

N
0 30
Scale in Feet

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Washington: Issaquah | Bellingham | Seattle
Oregon: Portland | Bend | Baker City
California: Oakland | Sacramento | Irvine
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FIGURE 3A

PLANT 4 SOIL ANALYTICAL RESULTS AND TETRACHLOROETHENE SOIL GAS RESULTS
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5815 4TH AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: jjones | Checked By: JK | Date: 7/25/2017 | Disc Reference:

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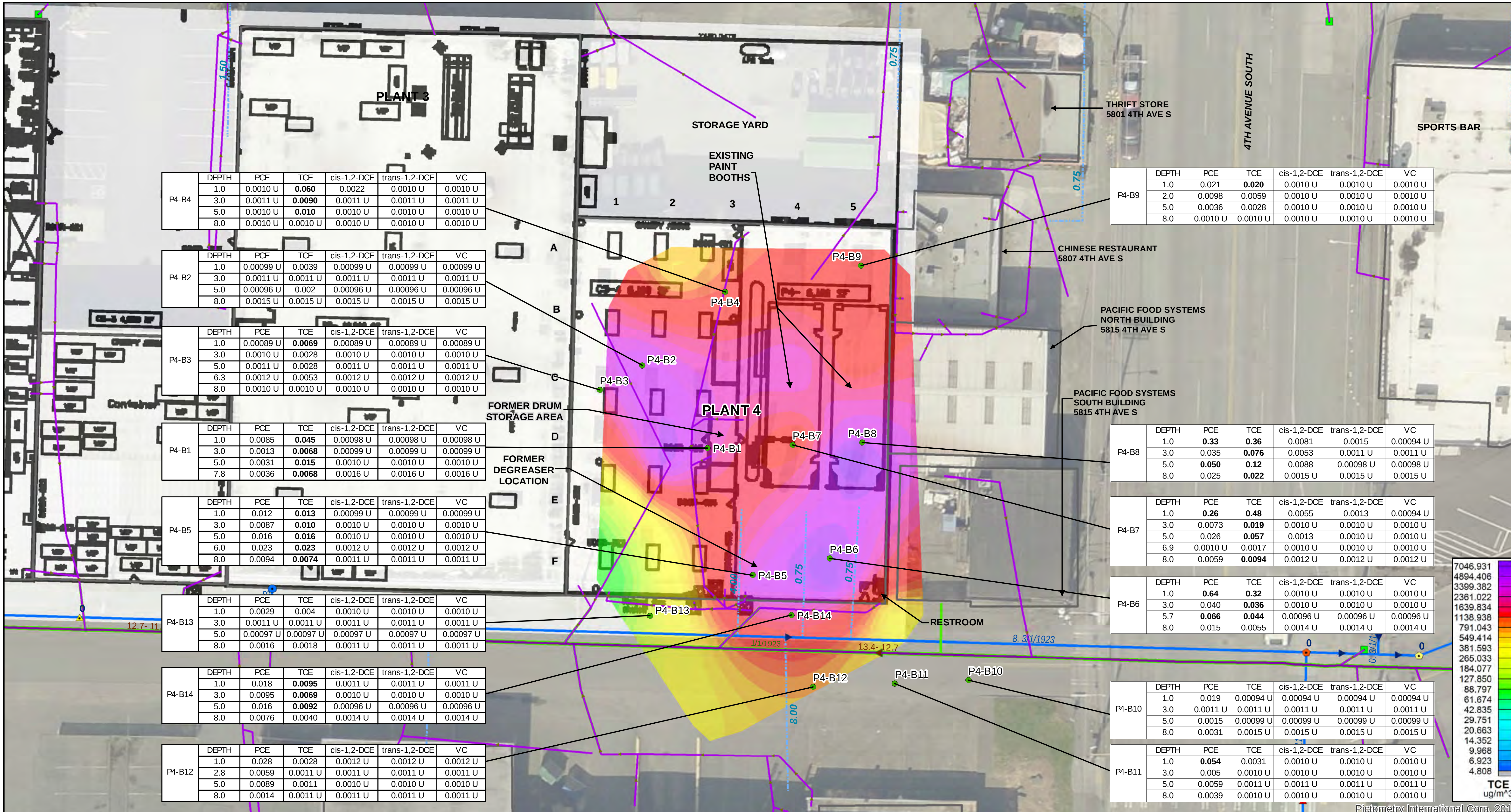

P4-B4	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	1.0	0.0010 U	**0.060**	0.0022	0.0010 U	0.0010 U
	3.0	0.0011 U	**0.0090**	0.0011 U	0.0011 U	0.0011 U
	5.0	0.0010 U	**0.010**	0.0010 U	0.0010 U	0.0010 U
	8.0	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U

P4-B2	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	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

P4-B3	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	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

P4-B1	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	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

P4-B5	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	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

P4-B13	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	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

P4-B14	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	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

P4-B12	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	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

P4-B9	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	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

P4-B8	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	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

P4-B7	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	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

P4-B6	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	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

P4-B10	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	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

P4-B11	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
	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.
5815 4TH AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: jjones | Checked By: JK | Date: 7/25/2017 | Disc Reference:
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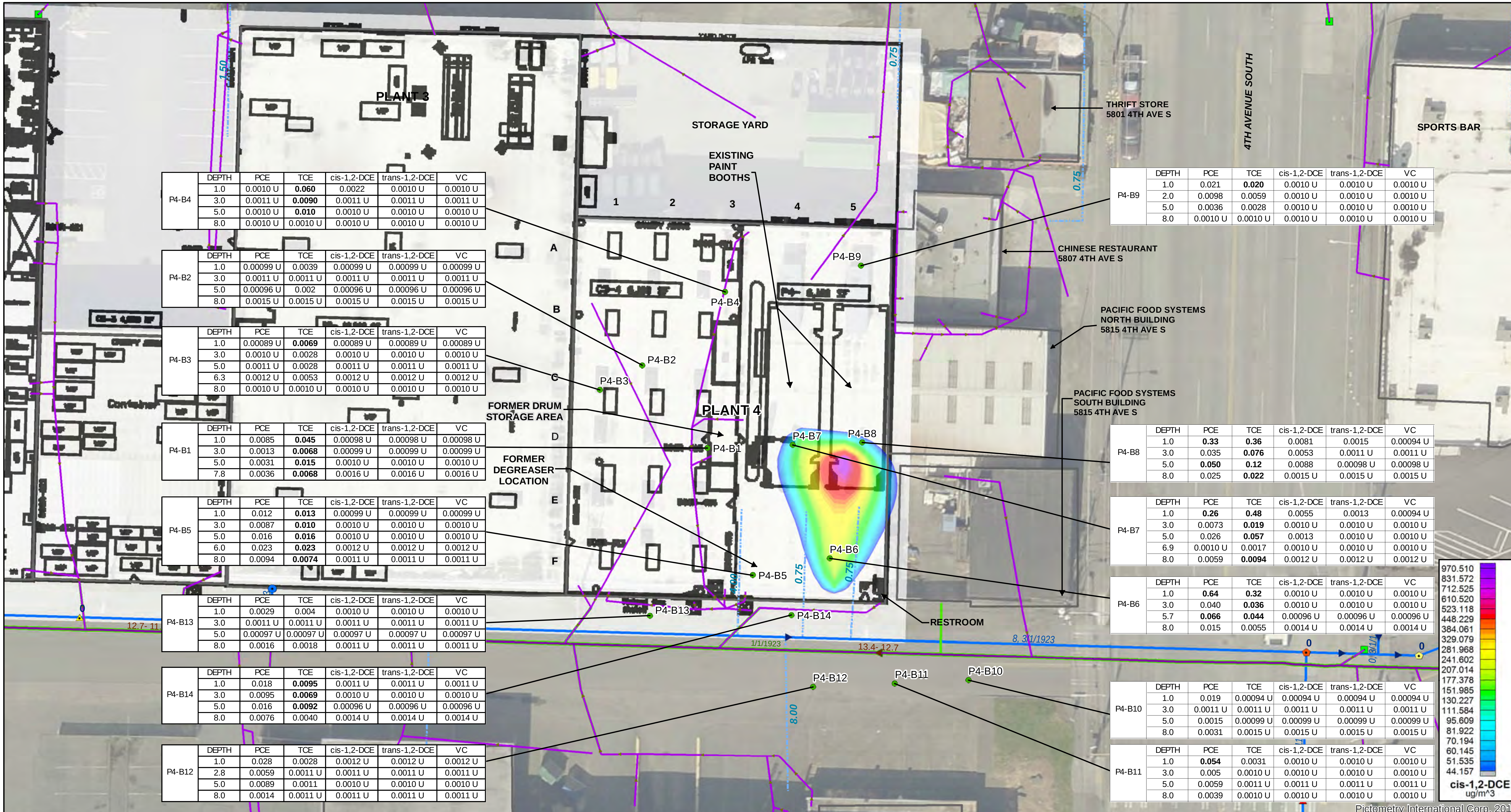

	DEPTH	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
P4-B4	1.0	0.0010 U	**0.060**	0.0022	0.0010 U	0.0010 U
	3.0	0.0011 U	**0.0090**	0.0011 U	0.0011 U	0.0011 U
	5.0	0.0010 U	**0.010**	0.0010 U	0.0010 U	0.0010 U
	8.0	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U

	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 3C

PLANT 4 SOIL ANALYTICAL RESULTS AND
CIS-1,2,DICHLOROETHENE SOIL GAS RESULTS
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5815 4TH AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

Drawn By: jjones | Checked By: JK | Date: 7/25/2017 | Disc Reference:

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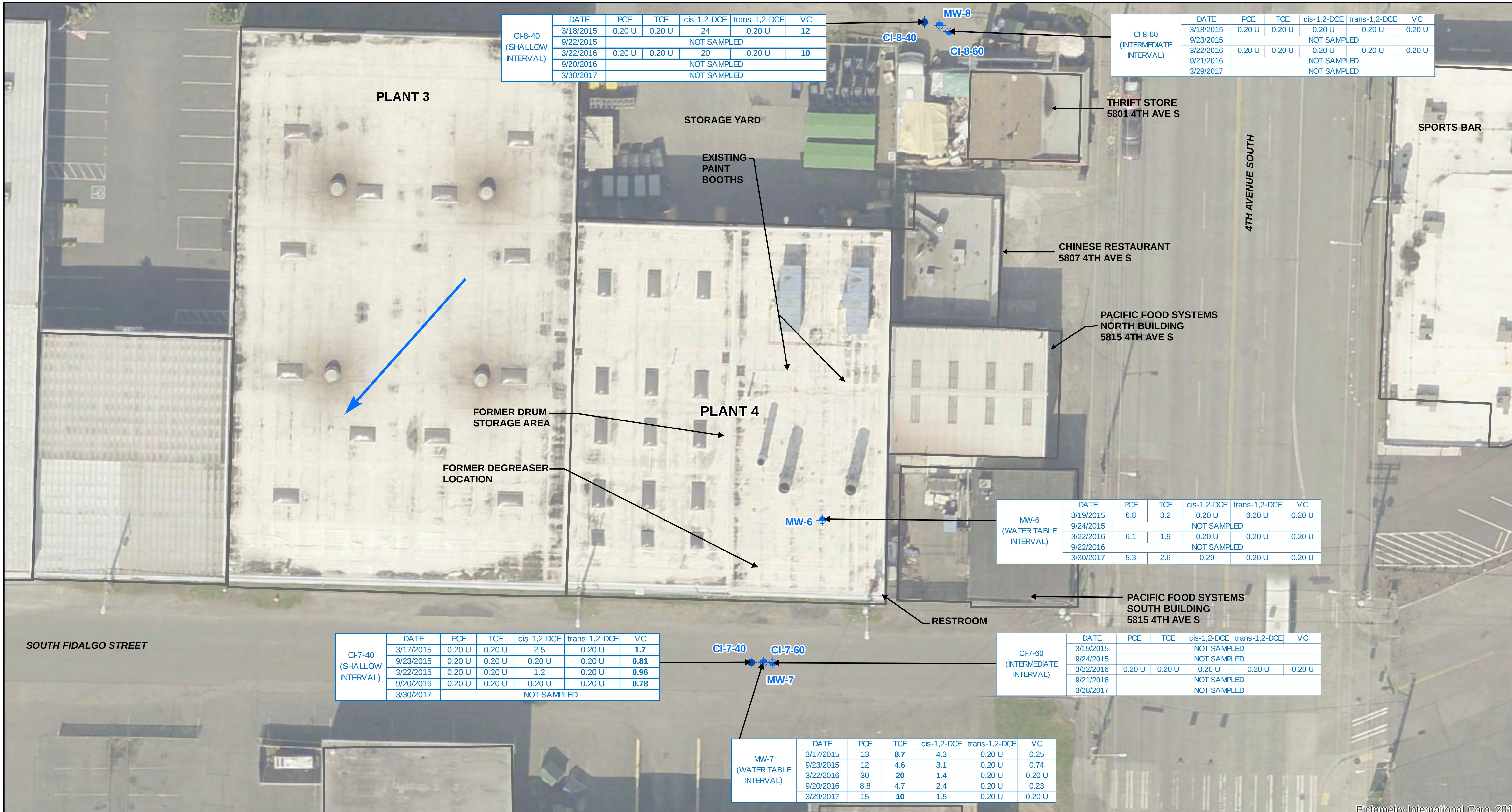

CI-8-40 (SHALLOW INTERVAL) DATE	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	VC
3/18/2015	0.20 U	0.20 U	24	0.20 U	**12**
9/22/2015	NOT SAMPLED				
3/22/2016	0.20 U	0.20 U	20	0.20 U	**10**
9/20/2016	NOT SAMPLED				
3/30/2017	NOT SAMPLED				

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.
5815 4TH AVENUE SOUTH
SEATTLE, WASHINGTON

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LEGEND

- STAGE 1 ISCO INJECTION POINTS
- STAGE 2 ISCO INJECTION POINTS
- INJECTION GRID CELL
- AREA WITH ISCO INJECTION POINT TO 25 FEET BGS
- WATER TABLE INTERVAL MONITORING WELL
- SHALLOW INTERVAL MONITORING WELL
- INTERMEDIATE INTERVAL MONITORING WELL

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Scale in Feet

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FIGURE 5

PLANT 4 ISCO INJECTION POINTS
WEST OF 4TH GROUP SITE
CAPITAL INDUSTRIES, INC.
5815 4TH AVENUE SOUTH
SEATTLE, WASHINGTON

FARALLON PN: 457-008

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TABLES

INTERIM ACTION WORK PLAN
Site Unit 2
Seattle, Washington

Farallon PN: 457-008

Table 1
Summary of Soil Analytical Results for CI Plant 4
West of 4th Group Site
Capital Industries, Inc.
5815 4th 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 1
Summary of Soil Analytical Results for CI Plant 4
West of 4th Group Site
Capital Industries, Inc.
5815 4th 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 1
Summary of Soil Analytical Results for CI Plant 4
West of 4th Group Site
Capital Industries, Inc.
5815 4th 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]**

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 calculated using Model Toxics Control Act (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 are 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 2
Summary of Groundwater Analytical Results for CI Plant 4
West of 4th Group Site
Capital Industries, Inc.
5815 4th 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 Zone								
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
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
Preliminary Cleanup Levels-Water Table Zone			**116** [2]		**6.9** [2]	**NR** [3]	**559** [2]	**1.3** [2]

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Table 2
Summary of Groundwater Analytical Results for CI Plant 4
West of 4th Group Site
Capital Industries, Inc.
5815 4th 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 Zone							
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 Zone			**116 [2]**	**6.9 [2]**	**NR [3]**	**559 [2]**	**1.3 [2]**
Shallow Zone							
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 Zone			**2.9 [4]**	**0.7 [4]**	**NR [3]**	**1,000 [4]**	**0.18 [4]**

Table 2
Summary of Groundwater Analytical Results for CI Plant 4
West of 4th Group Site
Capital Industries, Inc.
5815 4th 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-8-40-032410	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 Zone			**2.9** [4]	**0.7** [4]	**NR** [3]	**1,000** [4]	**0.18** [4]
Intermediate Zone							
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 Zone			**2.9** [4]	**0.7** [4]	**NR** [3]	**1,000** [4]	**0.18** [4]

Table 2
Summary of Groundwater Analytical Results for CI Plant 4
West of 4th Group Site
Capital Industries, Inc.
5815 4th 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 Zone			**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.

CI = Capital Industries, Inc.
µg/l = micrograms per liter
J = result is an estimate
PCE = tetrachloroethene
Shallow Zone = groundwater collected from 20 to 40 feet below ground surface
TCE = trichloroethene

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

Table 3
Summary of Preliminary Cleanup Levels
Updated January 17, 2017
West of 4th Group Site
Capital Industries, Inc.
5815 4th 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] Backgound metals values from Washington State Department of Ecology Publication No. 94-115, Natural Background Soil Metals Concentrations in Washington State. Arsenic background from Washington State Model Toxics Control Act (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. Refer to the Surface Water Cleanup Levels Protective of Human Health and Aquatic Life 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 listed in CLARC, with the exception of: (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 Human Health Criteria - Organism Only dated 11/15/16.

[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 are not listed in the Sediment Managment Standards (WAC 173-204), either. EPA Region 3 BTAG Marine Sediment Ecological Screening Benchmarks (EPA 2006) have been listed for nickel, TCE, and PCE. EPA Region 3 has no value listed for vinyl chloride; therefore, the older Region 5 benchmarks were used (EPA 2003).

[10] Arsenic Cleanup level of 5 μg/l based on background concentrations for the State of Washington (MTCA Table 720-1).

[11] The surface water cleanup level for copper had previously 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. We have replaced this with 3.1 μg/l, National Recommended Water Quality Criteria published by EPA under 304 of the Federal Clean Water Act - Aquatic Life Criteria Table.

[12] Based on the Oak Ridge Nation 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 published by EPA under 304 of the Federal Clean Water Act - Aquatic Life Criteria Table

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

Table 4
Summary of Natural Attenuation and Water Quality Parameters
West of 4th Group Site
Capital Industries, Inc.
5815 4th Avenue South
Seattle, Washington
Farallon PN: 457-008

		Electron Receptors			Total and Dissolved Metals				Metabolic Byproducts			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)
Water Table Zone																
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

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Table 4
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		Electron Receptors			Total and Dissolved Metals				Metabolic Byproducts			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)
Water Table Zone																	
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 Zone																	
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

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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)
Shallow Zone																
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
Intermediate Zone																
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 Yellow Springs Instrument multimeter with flow-through cell.

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

[3]Analyzed by American Society for Testing and Materials 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

J = result is an estimate

metabolic byproducts = compounds that result from biodegradation processes

mg/l = milligrams per liter; equivalent to parts per million

mS/cm = milliSiemens per centimeter specific conductance units

mV = millivolt units for measurement of oxidation-reduction potential (ORP)

µg/l = micrograms per liter

NA= not analyzed

TOC = total organic carbon

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APPENDIX A
A CITIZEN'S GUIDE TO IN SITU CHEMICAL OXIDATION

INTERIM ACTION WORK PLAN
Site Unit 2
Seattle, Washington

Farallon PN: 457-008

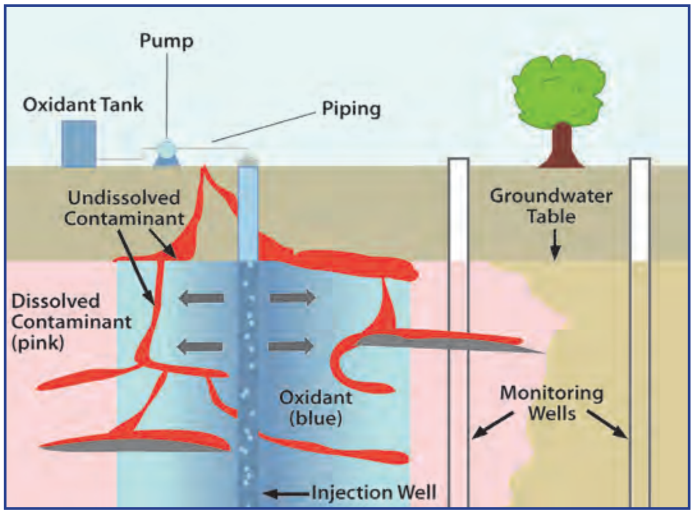
A Citizen's Guide to In Situ Chemical Oxidation

What Is In Situ Chemical Oxidation?

Chemical oxidation uses chemicals called "oxidants" to help change harmful contaminants into less toxic ones. It is commonly described as "in situ" because it is conducted in place, without having to excavate soil or pump out groundwater for aboveground cleanup. In situ chemical oxidation, or "ISCO," can be used to treat many types of contaminants like fuels, solvents, and pesticides. ISCO is usually used to treat soil and groundwater contamination in the source area where contaminants were originally released. The source area may contain contaminants that have not yet dissolved into groundwater. Following ISCO, other cleanup methods, such as pump and treat or monitored natural attenuation, are often used to clean up the smaller amounts of contaminants left behind. (See *A Citizen's Guide to Pump and Treat* [EPA 542-F-12-017] and *A Citizen's Guide to Monitored Natural Attenuation* [EPA 542-F-12-014].)

How Does It Work?

When oxidants are added to contaminated soil and groundwater, a chemical reaction occurs that destroys contaminants and produces harmless byproducts. To treat soil and groundwater in situ, the oxidants are typically injected underground by pumping them into wells. The wells are installed at different depths



in the source area to reach as much dissolved and undissolved contamination as possible. Once the oxidant is pumped down the wells, it spreads into the surrounding soil and groundwater where it mixes and reacts with contaminants.

To improve mixing, the groundwater and oxidants may be recirculated between wells. This involves pumping oxidants down one well and then pumping the groundwater mixed with oxidants out another well. After the mixture is pumped out, more oxidant is added, and it is pumped back (recirculated) down the first well. Recirculation helps treat a larger area faster. Another option is to inject and mix oxidants using mechanical augers or excavation equipment. This may be particularly helpful for clay soil.

The four major oxidants used for ISCO are permanganate, persulfate, hydrogen peroxide and ozone. The first three oxidants are typically injected as liquids. Although ozone is a strong oxidant, it is a gas, which can be more difficult to use. As a result, it is used less often.

Catalysts are sometimes used with certain oxidants. A catalyst is a substance that increases the speed of a chemical reaction. For instance, if hydrogen peroxide is added with an iron catalyst, the mixture becomes more reactive and destroys more contaminants than hydrogen peroxide alone.

Following treatment, if contaminant concentrations begin to climb back up or "rebound," a second or third injection may be needed. Concentrations will rebound if the injected oxidants did not reach all of the contamination, or if the oxidant is used up before all the contamination is treated. It may take several weeks to months for the contamination to reach monitoring wells and to determine if rebound is occurring.

ISCO may produce enough heat underground to cause the contaminants in soil and groundwater to evaporate and rise to the ground surface. Controlling the amount of oxidant helps avoid excessive heat, and if significant gases are produced, they can be captured and treated.

How Long Will It Take?

ISCO works relatively quickly to clean up a source area. Cleanup may take a few months or years, rather than several years or decades. The actual cleanup time depends on several factors that vary site to site. For example, ISCO will take longer where:

- The source area is large.
- Contaminants are trapped in hard-to-reach areas like fractures or clay.
- The soil or rock does not allow the oxidant to spread quickly and evenly.
- Groundwater flow is slow.
- The oxidant does not last long underground.

Is ISCO Safe?

The use of ISCO poses little risk to the surrounding community. Workers wear protective clothing when handling oxidants, and when handled properly, these chemicals are not harmful to the environment or people. Because contaminated soil and groundwater are cleaned up underground, ISCO does not expose workers or others at the site to contamination. Workers test soil and groundwater regularly to make sure ISCO is working.

How Might It Affect Me?

Nearby residents and businesses may see drilling rigs and tanker trucks with oxidants and supplies as they are driven to the site. Residents may also hear the operation of drilling rigs, pumps, and other equipment leading up to and during the injection period. Following an injection, however, the cleanup process occurs underground with little aboveground disruption. Workers may visit the site to collect soil and groundwater samples to monitor cleanup progress.

Why Use ISCO?

ISCO is usually selected to clean up a source area, where it destroys the bulk of contaminants in situ without having to dig up soil or pump out groundwater for aboveground treatment. This can save time and money. ISCO has successfully cleaned up many contaminated sites and has been selected or is being used at around 40 Superfund sites and many other sites across the country.

ISCO system installed behind a small drycleaning facility.

Example

Groundwater near a former wastewater treatment plant at the Naval Air Station Pensacola in Florida was contaminated with solvents and acids from painting and electroplating. A groundwater pump and treat system had operated for more than 10 years to control migration of contaminated groundwater. However, it did not do much to lower the concentrations of contaminants. ISCO using hydrogen peroxide with an iron catalyst was chosen to reduce contaminant concentrations in the source area enough to allow monitored natural attenuation to complete the cleanup.

The natural chemistry of the site's groundwater was found to limit the effectiveness of the first phase of injections. In the second phase, a chemical was added to the reagent mix to stabilize the oxidant mixture. Contaminant levels fell substantially. The successful use of ISCO at this site was estimated to save several million dollars compared with continued pump and treat.

For More Information

For more information about this and other technologies in the Citizen's Guide Series, visit:

www.cluin.org/remediation
www.cluin.org/products/citguide
www.cluin.org/chemox

United States Environmental Protection Agency

Office of Solid Waste and Emergency Response (5102G)

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www.epa.gov/superfund/sites
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