INTERIM ACTION WORK PLAN
HOWE PARCEL
UNIVERSITY OF WASHINGTON TACOMA

For

UNIVERSITY OF WASHINGTON
URS Corporation
Project No. 33762555

July 2012

Revisions to IAWP dated July 2012
December 5, 2012

The following revisions are applicable to the *Interim Action Work Plan, Howe Parcel, University of Washington Tacoma*, dated July 2012. These revisions are based on Washington State Department of Ecology's (Ecology's) letter to University of Washington dated November 29, 2012 "Conditional Approval, Interim Action Work Plan, Howe Parcel, University of Washington, Tacoma".

1. Table 3-1 of IAWP has been revised to show detection limit ranges for PCE degradation constituents that were previously listed as not applicable. Additionally, the heading notes on the revised Table 3-1 have also been formatted as superscripts and new note ("e") was added to reference the source of information for the ranges of detection limits for the PCE degradation constituents. The revised Table 3-1 is provided below:

Table 3-1 (Revised)
Principal COPCs and Concentration Ranges above IA Cleanup Levels
Former Howe Parcel, UW Tacoma

	Groundwater				
Contaminant of Potential Concern	**MTCA Method A Level (µg/L)**	**MTCA Method B Level (µg/L)**	**IA Cleanup Level[b] (µg/L)**	**IA Action Level[c] (µg/L)**	**Concentration Range Detected Above MTCA and IA Cleanup Level[d] (µg/L)**
PCE	5.0	NA	5.0	3.75	6.57–311
TCE[a]	5.0	NA	5.0	3.75	5.49–12
cis-1,2 DCE[a]	NA	16	NA	12	0.0500 – 1.00[e]
trans-1,2 DCE[a]	NA	160	NA	120	0.100 – 0.200[e]
1,1-DCE[a]	NA	400	NA	300	0.0500 – 0.200[e]
Vinyl Chloride[a]	NA	0.2	NA	0.15	0.0200 – 0.200[e]

Notes:
[a] Potential degradation product from PCE.
[b] Applicable IA cleanup level for Howe Parcel PCE Plume is MTCA Method A
[c] IA action level is 75-percent of IA cleanup level or 75-percent of MTCA Method B level if there is no established Method A level
[d] Concentration range includes data from groundwater samples collected from monitoring wells and borings (grab and probe samples)
[e] These values are the ranges for analytical reporting limits for PCE degradation constituents, none of which were detected above reporting limits. See Table 4-1 for reporting limits for specific analytes in specific samples
DCE–dichloroethene
MTCA–Model Toxics Control Act
NA-not applicable
PCE – tetrachloroethene
TCE–trichloroethene

2. Metals sampling and analysis. Analysis for metals (arsenic and chromium) will be conducted as part of compliance monitoring to monitor potential metal mobilization resulting from reducing conditions caused by the interim action injections. Samples will be collected and analyzed for arsenic and chromium (total chromium and hexavalent chromium) prior to the injections for baseline conditions and for four subsequent quarterly sampling events after the injections.

3. The following typographic errors are noted:

    a. Table of Contents should include:

        i. Section 2.3.1. Remedial Investigation, Page 2-5

        ii. Section 2.3.2. Howe PCE Groundwater Plume Investigation, Page 2-5

iii. Section 2.3.3 Indoor Air Sampling 2010 and 2011, Page 2-6

b. Figures 2-1 and 4-1 have been updated to identify the Federal Courthouse property lines because they are referenced in the text on pages 2-1 and 3-3.

c. Pg. 6-1, last paragraph, first sentence should reference Section 6.3 not 6.4.

d. Table A-3. The identification of sample locations in the Federal Courthouse will be changed from H-FC-1 to H-GW12, from H-FC-2 to H-GW13, and from H-FC-3 to H-GW14 to be consistent with Figure A-2, Proposed Groundwater Monitoring Locations, Federal Courthouse, Ground Floor.

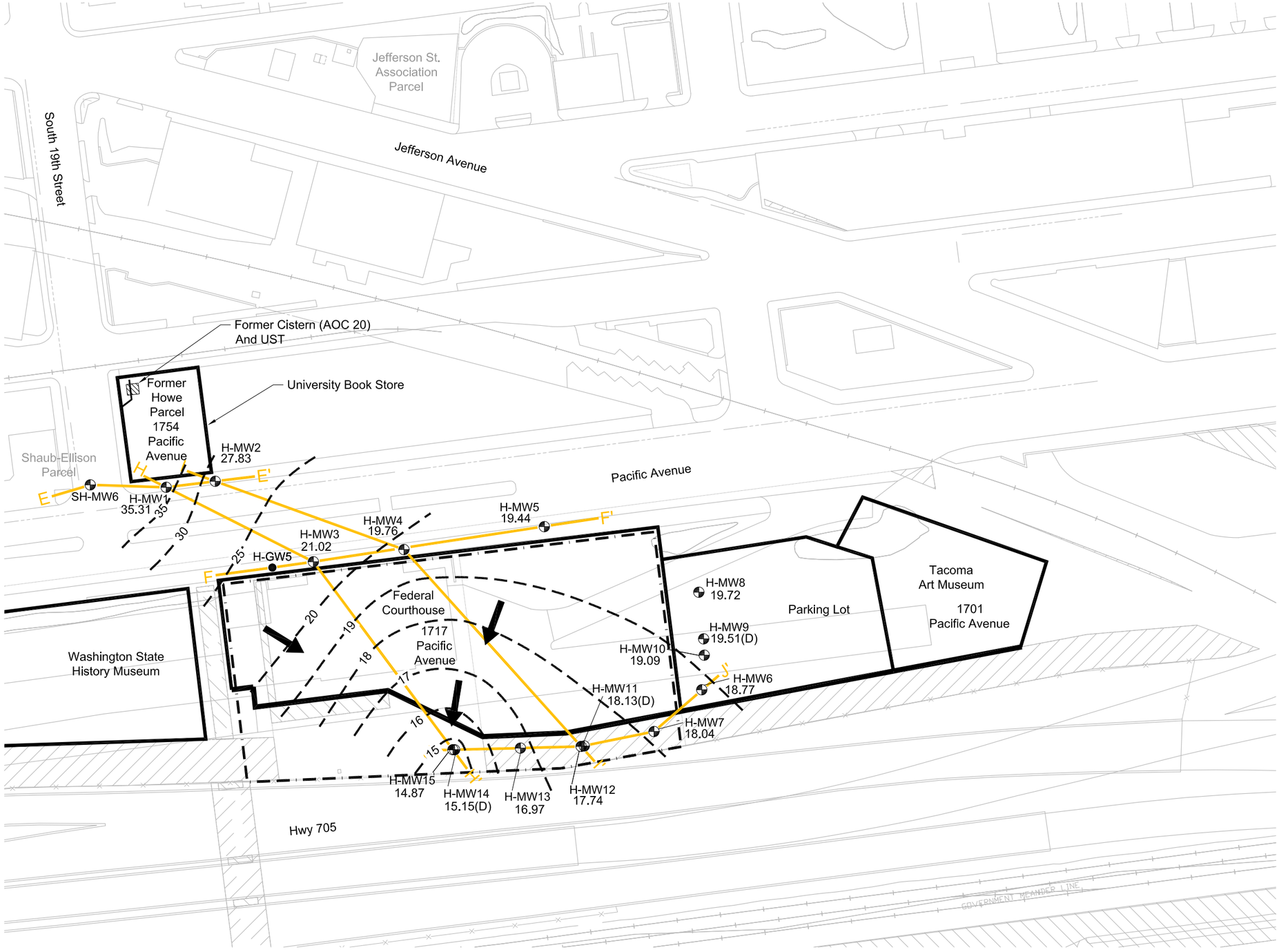

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Figure 2-1

Geologic Cross-Section Location and Groundwater Elevation Contour Map

University of Washington Tacoma Campus
Howe Parcel
INTERIM ACTION WORKPLAN

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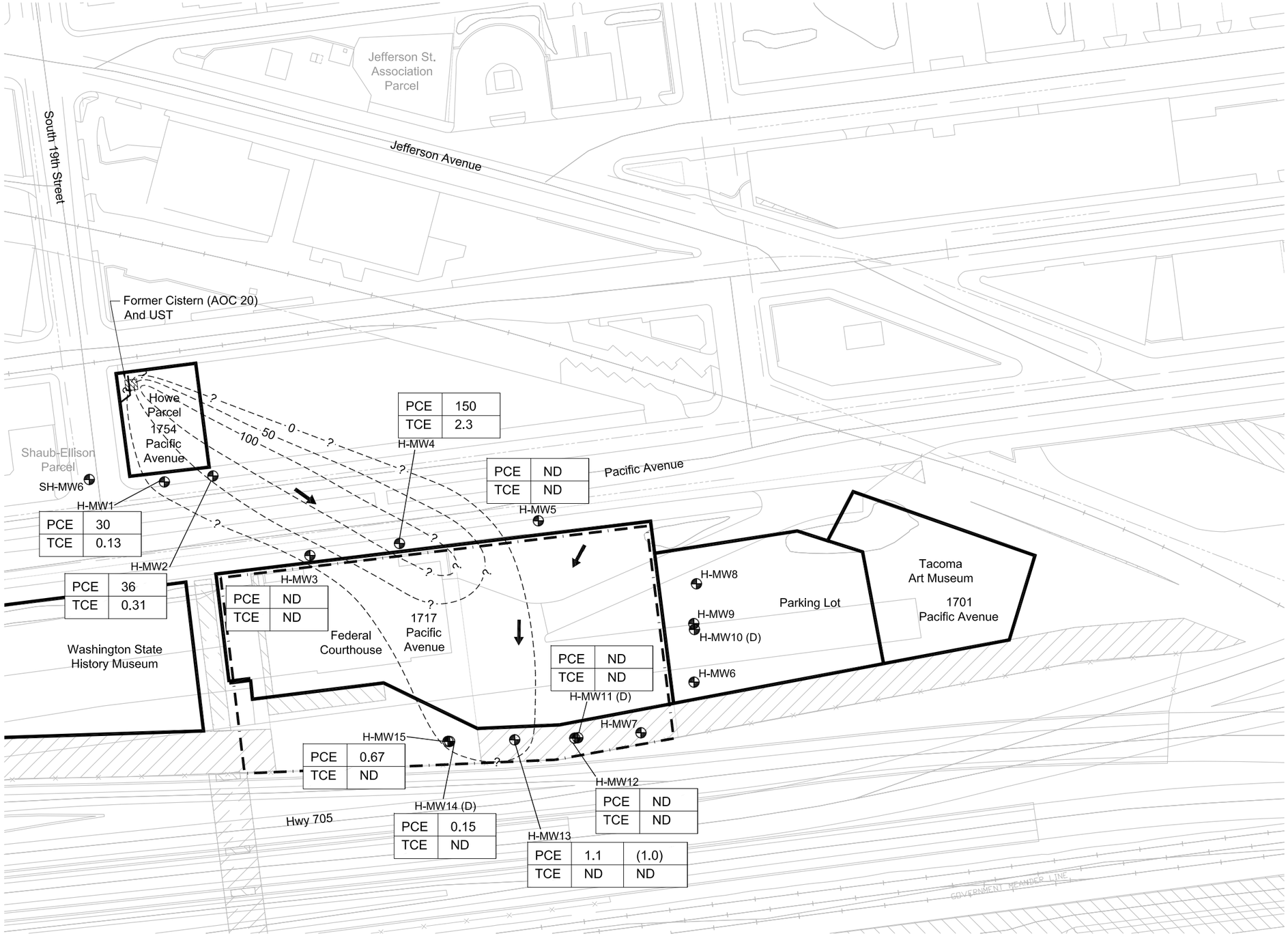

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Figure 4-1

PCE and TCE Concentrations in Groundwater

University of Washington Tacoma Campus
Howe Parcel
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ACRONYMS

µg/L	micrograms per liter
µg/m^3	micrograms per cubic meter
AOC	area of concern
ARARs	applicable or relevant and appropriate requirements
bgs	below ground surface
BNRR	Burlington Northern Railroad
COPCs	contaminants of potential concern
DCE	dichloroethene
DNS	Determination of Non-Significance
Ecology	Washington State Department of Ecology
ERD	Enhanced Reductive Dechlorination
FS	Feasibility Study
GAC	granular activated carbon
I-5	Interstate 5
I-705	Interstate 705
IA	interim action
IAAA	interim action alternatives analysis
IAWP	Interim Action Work Plan
mg/kg	milligrams per kilogram
mg/kg/day	milligrams per kilogram per day
msl	mean sea level
MTCA	Model Toxics Control Act
PCE	tetrachloroethene
PRB	permeable reactive barrier
psi	pounds per square inch
RCW	Revised Code of Washington
RELs	remediation levels
RI	remedial investigation
SEPA	State Environmental Policy Act
SR	State Route

SWMU	solid waste management unit
TCE	trichloroethene
TPH	total petroleum hydrocarbons
UST	underground storage tank
UW	University of Washington
VC	vinyl chloride
VOCs	volatile organic compounds
WAC	Washington Administrative Code
ZVI	Zero Valent Iron

1.0 INTRODUCTION

This Interim Action Work Plan (IAWP) describes the groundwater remedial action selected for a tetrachloroethene (PCE) groundwater plume that originated on the former Howe Parcel, located at the University of Washington (UW) Tacoma Campus in Tacoma, Washington (Figure 1-1). The plume was detected and characterized during a campus-wide remedial investigation (RI) (URS 2002) conducted under Agreed Order DE97HW-S238, effective October 1, 1997, between the UW and Washington State Department of Ecology (Ecology). Potential groundwater remedial alternatives for the PCE plume were evaluated in the draft Interim Action Alternatives Analysis Report (IAAA) (URS 2011d). As reported therein, the groundwater interim action (IA) selected was Alternative A-7: Combination of Zero Valent Iron (ZVI) and Enhanced Reductive Dechlorination (ERD). Ecology concurred with this selected IA.

Groundwater remediation at the former Howe Parcel will be undertaken by UW as an IA in accordance with: (1) an amendment to Agreed Order No. DE97HW-S238, (2) the Model Toxics Control Act (MTCA), Revised Code of Washington (RCW) Chapter 70.105D, and (3) the MTCA Cleanup Regulation (Washington Administrative Code [WAC] Chapter 173-340). This work is an IA because it is focused solely on the former Howe Parcel Tetrachloroethene (PCE) groundwater plume (Howe PCE plume), and does not address other soil and groundwater plumes identified during the RI (URS 2002).

The IA will address areas where hazardous substances originating from the former Howe Parcel property at 1754 Pacific Ave. in Tacoma, Washington have come to be located (Howe PCE plume). These areas include groundwater beneath the current University Bookstore, portions of Pacific Ave. (and associated City of Tacoma right-of-way), and the Federal Courthouse property (aka Union Station Courthouse) located at 1717 Pacific Ave. as described and shown on the figures in Section 4.0.

The main objective of the IA is to reduce volatile organic compound (VOC) concentrations (primarily PCE and environmental degradation products of PCE) in groundwater that are associated with the Howe PCE plume. In addition, reducing groundwater PCE concentrations is expected to lower the potential for vapor intrusion of VOCs from the groundwater plume within the Federal Courthouse and the University Bookstore buildings. Indoor air quality at the University Bookstore and Federal Courthouse buildings, including additional indoor air sampling, will be addressed independently of this IA under a future UW Tacoma Campus-Wide Agreed Order between the UW and Ecology.

The portion of the remedial investigation specific to the Howe PCE plume is complete. However, the remedial investigation for the entire UW Tacoma Campus Site is not yet complete. The term “Site” refers to all areas where hazardous substances originating from the UW Tacoma Campus have come to be located, which is broader than the PCE groundwater plume from the former Howe Parcel. The boundaries of the Site have not yet been fully established.

1.1 PURPOSE AND SCOPE OF INTERIM ACTION

The selected interim groundwater cleanup action is designed to accomplish the following requirements:

- Protect human health and the environment
- Meet requirements for interim actions under WAC 173-340-430
- Comply with interim action cleanup standards developed in accordance with WAC 173-340-700
- Comply with applicable state and federal laws under WAC 173-340-710
- Provide compliance monitoring as set forth in WAC 173-340-410
- Provide a reasonable time restoration in accordance with WAC 173-340-360(4)

The purpose of the IAWP is to provide information regarding the selected groundwater IA for the former Howe Parcel, as documented in the draft IAAA. Details on how to implement the IA are also documented. The primary purpose of the IA is to protect human health and the environment by reducing concentrations of PCE and other contaminants of potential concern (COPCs) in the groundwater to IA cleanup levels. A reduction in PCE concentrations in groundwater within the former Howe Parcel plume also is expected to reduce the PCE vapor intrusion concentrations in the nearby Federal Courthouse building and University Bookstore, located on the former Howe Parcel.

1.2 INTERIM ACTION RESPONSIBILITIES

UW is the responsible party for overall implementation and maintenance of the IA for the former Howe Parcel (including other properties affected by migration of contaminants originating from the former Howe Parcel) pursuant to RCW 70.105D.040(1). The IA will be performed under Ecology's regulatory oversight and in accordance with the Agreed Order as amended, MTCA (RCW 70.105D), and the MTCA Cleanup Regulation (WAC Chapter 173-340).

1.3 ADMINISTRATIVE DOCUMENTATION

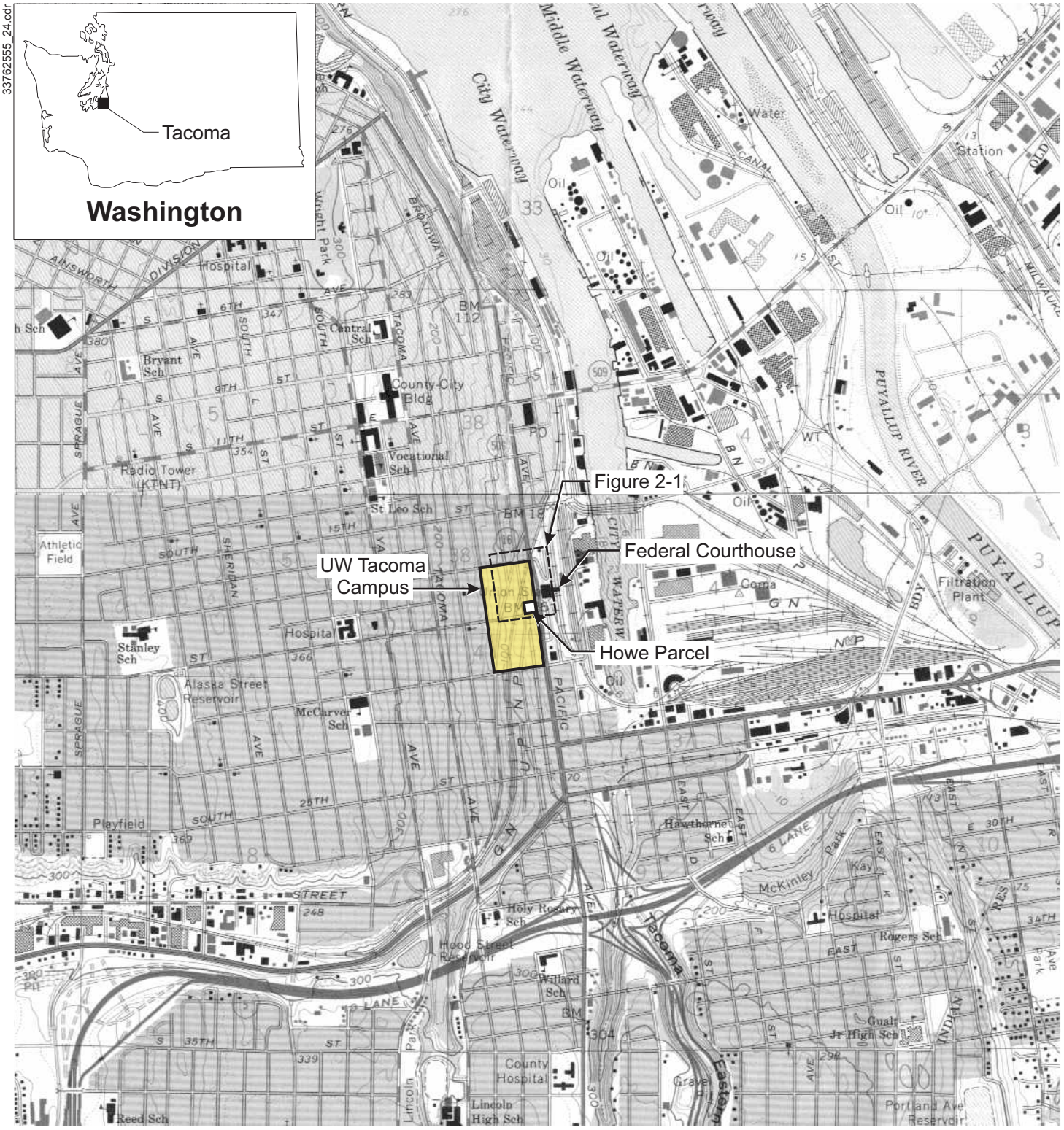
Documents used to develop this IAWP and the decisions contained herein are provided in Ecology's files. The administrative record for the Site is on file and available for public review by appointment at Ecology's Southwest Regional Office, located at 300 Desmond Drive, Lacey, Washington. The following documents were used to develop the proposed IA:

- Remedial Investigation and Feasibility Study Work Plan (Dames & Moore 1998)
- Supplemental Remedial Investigation Work Plan, UW Tacoma Campus (URS 2001)
- Draft Remedial Investigation Report (Rev 1.1) University of Washington, Tacoma Campus (URS 2002)[1]
- Agency Review Draft Feasibility Study for University of Washington, Tacoma Campus (URS 2003)[2]

[1] The remedial investigation for the UW Tacoma Campus Site is not yet complete.

[2] The feasibility study for the UW Tacoma Campus Site is not yet complete.

- Technical Memorandum #1, Results of Groundwater Sample Analysis, Well HMW-6, Howe PCE Groundwater Plume, UW Tacoma Campus (URS 2008a)
- Technical Memorandum #2, Results of Analysis, Hydraulic Probe Boring Groundwater Samples, Howe PCE Groundwater Plume, UW Tacoma Campus (URS 2008b)
- Technical Memorandum #3 (Rev 1), Results of Analysis, Groundwater Monitoring Well Samples, Howe PCE Groundwater Plume, UW Tacoma Campus (URS 2008c)
- Technical Memorandum #4, Results of Analysis, Groundwater Monitoring Well Samples, February 2008, Howe PCE Groundwater Plume, UW Tacoma Campus (URS 2009a)
- Technical Memorandum #5, Results of Drilling and Groundwater Monitoring Well Samples, April–May 2009, Howe PCE Groundwater Plume, UW Tacoma Campus (URS 2009b)
- Technical Memorandum #6, Results of Groundwater Monitoring Well Samples, May 27–28, 2009, Howe PCE Groundwater Plume, UW Tacoma Campus (URS 2009c)
- Technical Memorandum #7, Cleanup Action Alternatives Memorandum, Howe PCE Groundwater Plume, UW Tacoma Campus (URS 2009d)
- Draft Supplemental Feasibility Study, Howe and Williams Parcels, UW Tacoma Campus, Tacoma, Washington (URS 2010a)
- Supplemental Work Plan (Rev1.1) Indoor Air and Groundwater Sampling Federal Courthouse Draft Supplemental, Tacoma, Washington. November 8 (URS 2010b)
- Technical Memorandum #8, Results of Groundwater Monitoring Well and Federal Courthouse Indoor Air Sampling, December 9 and 10, 2010, Howe PCE Groundwater Plume, UW Tacoma Campus (URS 2011a)
- Draft Interim Action Alternatives Analysis, Howe Parcel, University of Washington Tacoma Campus (URS 2011d)



SOURCE: USGS Topographic maps; Tacoma North and Tacoma South, Washington; dated 1961, photorevised 1981 and 1968, respectively

Job No. 33762555

Figure 1-1

Location Map

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University of Washington, Tacoma Campus
Howe Parcel
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2.0 BACKGROUND

This section describes the physical location, history, and land use at the former Howe Parcel, as well as the regional and site-specific hydrogeological setting and previous investigations conducted at the former Howe Parcel. Detailed information regarding the entire UW Tacoma Campus is contained in the draft RI report (URS 2002).

2.1 SITE DESCRIPTION

2.1.1 Physical Location

The UW Tacoma Campus is located on approximately 46 acres of land located in the historic Union Station Warehouse District in downtown Tacoma (Figure 1-1). Pacific Ave. and Tacoma Ave. bound the campus to the east and west. The north boundary of the campus lies along South 17th Street and the south boundary is South 21st Street. The campus is located within three blocks of Tacoma's central business district and several key historic districts and development areas. The Federal Courthouse and the Washington State History Museum are located on the east side of Pacific Ave. The University Bookstore is located in the renovated building on the former Howe Parcel (Figure 2-1).

The core area of the campus comprises parcels of land acquired by UW from a variety of commercial and industrial property owners. The names of these parcels reflect historic ownerships and business activities of the acquired properties. Additionally, much of the available data regarding each solid waste management unit (SWMU) and area of concern (AOC) addressed in the RI is referenced by the parcel name or area designation. Figure 2-1 shows the boundaries of the former Howe Parcel and the adjacent Federal Courthouse property.

The campus is accessible from Interstate 705 (I-705) via a road spur that terminates at the intersection of Pacific and South 21st Street. The future State Route (SR) 509 will pass the campus's southeastern edge then turn south along Pacific Ave. to Interstate 5 (I-5). Major north-south arterials include Tacoma Ave. and Pacific Ave., which bracket the campus on the east and west. Jefferson Ave. passes diagonally through the campus and is the main thoroughfare within the campus. The former Burlington Northern Railroad (BNRR) Prairie Line right-of-way passes diagonally through the campus with a gradual ascent to the south.

2.1.2 Former Howe Parcel History and Land Use

The former Howe Parcel is located at 1754 Pacific Ave. A five-story brick building was constructed on the parcel prior to 1890. Historically, the building was used as a warehouse for furniture, dry goods, records, and business forms. The building was renovated by UW prior to the RI and is currently occupied by the UW Tacoma Campus bookstore. AOC 20 was identified on the parcel (SAIC 1996)

A former cistern (AOC 20) was discovered at the Howe Parcel in May 1996 during building renovation. The oil/water and sludge contents of the cistern and the sides and top of the cistern were removed at that time. A 3-inch pipe connected to the cistern was believed to be a footing drain. Water in the footing drain was analyzed and PCE was detected. The cistern and the associated footing drain were thought to be the source of the PCE contamination.

A 1,750-gallon heating oil underground storage tank (UST) was previously located underneath the former Howe Parcel, directly south of the cistern. The former UST was abandoned in place by filling the tank with concrete. Based on the conditions observed during the UST abandonment, it is likely that the former heating oil tank leaked. Petroleum-contaminated soil

around the tank was not excavated. The area was capped with concrete and the building was renovated and occupied by the University Bookstore. The UST was not identified as an SWMU or AOC under the Agreed Order.

The UW has a master plan that details the long-term development of 46 acres of property as the UW Tacoma Campus (UW 1993). Construction related to the development began in 1996 and is ongoing. The RI activities were conducted prior to and during construction/demolition work associated with the campus development under Phase I (completed in 1998) and Phase II of the master plan. Further development under Phase II was completed in 2003, followed by implementation of Phase III, with planned occupancy in 2011. These phases of development, current and planned uses, and access limitations associated with the continued development and use of the UW Tacoma Campus are expected to be key factors in implementing remedial actions. It is anticipated that UW will periodically update its master plan to reflect its mission and on-going changes in the surrounding urban setting. The most recent master plan for the UW Campus is dated November 20, 2008.

2.2 GEOLOGY AND HYDROGEOLOGY

This section summarizes the hydrogeology and groundwater occurrence at the UW Tacoma Campus Site[3] as defined in the Draft RI Report (URS 2002). This summary is based on pre-RI environmental subsurface investigations, RI supplemental groundwater monitoring data, published reports on the regional hydrogeology, and the preliminary RI results.

2.2.1 Topographic and Geologic Setting

The UW Tacoma Campus is located on the eastern flank of a north-sound trending upland in the southern portion of the Puget Sound Lowland. The upland is a peninsula bounded by the Tacoma Narrows to the west-northwest and by Commencement Bay to the east-northeast. The Tacoma tidal flats lie adjacent to the east of the site. The tidal flats contain areas of filled land on top of the natural tidal flat soils, separated by surface water within man-made waterways at the mouth of the Puyallup River, Wapato Creek, and Hylebos Creek. The waterways have undergone considerable dredging and channelization for water access to industries in this area. The nearest surface water is the Thea Foss (City) Waterway, approximately 900 feet east of the UW Tacoma Campus.

The topography and geology of the area is a result of the most recent Pleistocene glaciation, referred to as the Vashon Stade. The upland crest ranges in elevation from approximately 400 feet above mean sea level (msl) in the central portion to sea level around the north, east, and west margins. To the south is a broad upland region with elevations ranging from 300 to 400 feet above msl. The topography of the area slopes to the east and the elevation ranges from approximately 115 feet above msl at the southwest corner to 50 feet above msl along Pacific Ave. on the east.

Most of the Puget Sound Lowland is underlain by a thick sequence of unconsolidated Quaternary-age sediments deposited by alpine and continental glacial advances and recessions. These sediments overlie Tertiary-age and older bedrock of sedimentary and igneous origin. Sediments deposited during glacial advance were densely compacted by the glacial ice, and looser unconsolidated sediments were deposited as the glacier receded.

[3] The Site boundaries have not yet been defined.

The surficial native geologic material in the Tacoma peninsula consists of glacial deposits. The glacial deposits are collectively labeled Vashon Drift. In the downtown Tacoma area, these deposits comprise two main units known as Vashon till and Colvos Sand. Recessional outwash and alluvium locally overlie the till, and a non-glacial unit labeled the Kitsap Formation underlies the Colvos Sand (Walters and Kimmel 1968, Brown and Caldwell 1984, Jones et al. 1999). The Kitsap Formation is estimated to be at least 150 feet thick, with its base extending to sea level or deeper.

The UW Tacoma Campus is located on the eastern slope of the Tacoma upland. The ground surface slopes from an elevation of approximately 115 feet along Jefferson Ave. and Market Ave. on the west to approximately 50 feet at Pacific Ave. on the east. The natural slope was modified by a series of cuts and fills to provide flat parcels during original development of the area. Consequently, the geologic units that directly underlie the campus are a combination of natural and fill soils. In general, the fill consists of reworked glacial deposits from cut areas. A series of geologic cross-sections in the draft RI report (URS 2002) depict the subsurface soils encountered to the maximum depth explored (70 feet below ground surface [bgs]) during the RI.

The fill is typically 5 to 10 feet thick, except along deeply buried utilities and in the former excavations to clean up contaminated soil, where it is more than 10 to 20 feet thick. The fill is characterized by a mixture of silty sand, sand, and gravel. Backfill along buried utilities and in some local excavations includes imported sand and pea gravel. Some excavations were backfilled with the excavated soil after biological treatment. Where native glacial soils were used as fill, the fill is distinguished from the underlying glacial soils based on the significantly increased density of the native soils. Locally, silty and clayey soils (e.g., ML/CL soils on Figure 2-2 through 2-6) are present between the fill and dense glacial soils. These silty and clayey soils are not as dense as the glacial soils and are likely fill soil or colluvium that had filled erosional swales in the surface of the glacial soils.

The fill is underlain by dense glacial deposits comprised of recessional outwash, Vashon till (glacial till), and possibly advance outwash (Colvos Sand). The till consists of very dense, silty, fine to medium sand with varying amounts of gravel, coarse sand, and clay. It is the predominant unit underlying the fill and is up to 30 feet thick (typically depicted as SM on Figures 2-2 through 2-6). The till was deposited beneath the Vashon glacier. Locally, a silty sand and gravel unit (e.g., GM, SP, and GP on Figures 2-2 through 2-6) overlies the till and is interpreted to be recessional outwash deposited as the Vashon glacier receded. The discontinuous nature of this unit suggests it probably was deposited as a kame terrace at the ice margin with the Tacoma upland. However, the unit also may have been more extensive prior to soil excavation in some areas during grading for development of the area. The glacial till is underlain by advance glacial outwash (Colvos Sand), which consists of sand and gravel.

2.2.2 Groundwater Hydrology

The uppermost groundwater underlying the UW Tacoma Campus locally consists of perched water that occurs on the surface of the interface with glacial deposits and the overlying fill, as well as within coarse-grained lenses within the glacial till. These coarse-grained lenses are laterally discontinuous and supply very limited quantities of water to wells when saturated. Perched water was not encountered within the area investigated to assess the Howe PCE plume.

Throughout the UW Tacoma Campus and surrounding area, the uppermost contiguous groundwater typically occurs within glacial deposits at depths ranging from approximately 10 feet to 55 feet bgs, except east of Pacific Ave. beneath and adjacent to the Federal Courthouse,

where groundwater occurs at depths ranging from 1 to 7 feet bgs. Typical seasonal variations of 1 to 5 feet have been measured in individual monitoring wells. The shallow groundwater is unconfined and groundwater flow beneath the former Howe Parcel area is to the east-northeast. There are no known drinking water wells in the uppermost groundwater (perched or within the upper glacial deposits) located within one mile of the former Howe Parcel. There are a number of resource protection wells (monitoring wells) in this one-mile area.

The deeper groundwater-bearing zones (Colvos Sand and Kitsap Formation) can be unconfined or confined and typically have a static water level of approximately 60 to 100 feet bgs. The Colvos Sand and the unoxidized lower unit within the Kitsap Formation are regional groundwater supply sources. However, there are currently no known active wells used for potable water supply in these units in the vicinity of the former Howe Parcel.. Four former production wells were located approximately one block south of the site at the former Heidleberg Brewery (also known as Columbia Breweries and Carling Brewing Co.). These wells were screened in the Kitsap Formation at depths ranging from 132 to 652 feet bgs. One active, non-potable, service water well completed in the Kitsap Formation is located on the Almar Boat property located at 2301 Dock Street, approximately 0.25 mile southeast of the former Howe Parcel. The main well screen is from 146 to 301 feet bgs, and the shallowest well screen is at 90 feet bgs. Groundwater elevation data for the deepest zones are not available for the downtown Tacoma area, but flow direction is likely to be east-northeast, toward Commencement Bay.

The conclusions associated with groundwater occurrence and flow presented in the draft RI Report (URS 2002), a subsequent technical memo for the Howe PCE plume (URS 2011a), and draft IAAA (URS 2011d) are as follows:

- Uppermost groundwater is unconfined and typically occurs at a depth of approximately 13 to 23 feet bgs along the west side of Pacific Ave. (wells H-MW1 and H-MW2), 28 to 31 feet bgs along the east side of Pacific Ave. (wells HMW-3, H-MW4 and H-MW5), and 1 to 7 feet bgs on the Federal Courthouse and adjacent parking lot property (wells H-MW6 through H-MW15).
- The groundwater flow direction across the UW Tacoma Campus and within the Howe PCE plume is predominantly northeasterly to easterly toward the Thea Foss Waterway (Figure 2-1), which is consistent with previous interpretations of the regional groundwater flow in the UW Tacoma Campus vicinity. There is no significant seasonal change in flow direction.
- The groundwater gradient of the uppermost unconfined groundwater across the former Howe Parcel area is generally consistent with the overall topographic slope and is approximately 280 to 300 feet per mile (0.055 foot per foot). The gradient noticeably decreases to 0.035 foot per foot across Pacific Ave. between Howe Parcel monitoring wells H-MW2 and H-MW4, and then decreases further to 0.025 foot per foot to the east between H-MW4 and H-MW14/15. There is no apparent significant seasonal change in flow gradient.
- Groundwater elevations for paired monitoring wells BL-MW1/BL-MW5 and BL-MW3/BL-MW6 (located approximately 460 feet and 380 feet, respectively, southwest of the former Howe Parcel) in the south-central portion of the UW Tacoma Campus west of Pacific Ave. indicate there is a downward vertical gradient in the uppermost groundwater, whereas paired wells east of Pacific Ave. (H-MW9/H-

MW10 and H-MW14/H-MW15 on Figure 2-1) indicate there is an upward vertical gradient in the uppermost groundwater.

Table 2-1 summarizes groundwater elevations measured in wells installed to assess the Howe PCE plume.

2.3 PREVIOUS INVESTIGATIONS

Previous soil, groundwater, and indoor air investigations have been performed to document the nature and extent of hazardous substances at the former Howe Parcel and vicinity. Investigations relevant to the former Howe Parcel and the Federal Courthouse property are summarized below.

2.3.1 Remedial Investigation

An investigation was conducted at the UW Tacoma Campus from 1998 through 2002 to fulfill requirements specified in Agreed Order No. DE97HW-S238 between UW and Ecology. The investigation focused on selected SWMUs and AOCs located within the Dangerous Waste Management Facility (DWMF) and adjacent parcels. For the purposes of the RI, the SWMUs/AOCs were grouped into nine parcels based on their physical locations. AOC 20 was identified in the Agreed Order as being located on the former Howe Parcel.

A subsurface soil and groundwater investigation was conducted on and downgradient of the former Howe Parcel to assess the source of PCE in the vicinity of AOC 20, the presence and extent of PCE in groundwater beneath and downgradient of the former Howe Parcel, and the indoor air quality in the current University Bookstore building (URS 2002).

The soil constituents analyzed for were not detected or were detected below the applicable 1996 and 2001 MTCA cleanup levels.

PCE was detected in groundwater at concentrations (up to 311 µg/L) above the 1996 and 2001 MTCA Method A groundwater cleanup level of 5 µg /L in one or more groundwater samples from wells H-MW2, H-MW3, and H-MW4, and borings H-GW1, H-GW3, H-GW4, H-GW6, and H-GW7. TCE was also detected in groundwater at H-MW4 and H-GW7. Where vertical groundwater sampling was performed (H-GW4, H-GW6, and H-GW7) the PCE concentrations declined with depth. TPH as gasoline, diesel, and/or heavy oil and BTEX were detected at concentrations below applicable MTCA cleanup levels in several samples. Benzene was detected above MTCA Method B cleanup levels in samples from H-GW4 and H-GW6.

The lateral extent of the Howe PCE plume was estimated in various figures in the draft RI report (URS 2002). Groundwater quality data from the six wells (H-MW1 through H-MW6) installed to assess the PCE plume during the RI were sampled in September 1999 or September 2000. These data indicated that the PCE plume extended beyond the eastern side of Pacific Ave. but apparently had not migrated beyond the Federal Courthouse building.

An indoor air survey of the University Bookstore building on the former Howe Parcel (Figure 2-1) was performed in February 2001 and the results indicated that VOCs, including PCE, in the building indoor air were not above ambient VOC concentrations typical of urban environments and are likely associated with building materials.

2.3.2. Howe PCE Groundwater Plume Investigation

In 2008, a groundwater investigation was conducted to further evaluate the Howe PCE plume in order to reassess potential remedial actions that were outlined in the Draft Feasibility Study (FS) (URS 2003). Because it had been seven to eight years since the PCE plume had last been

sampled, groundwater monitoring was conducted in addition to installing new wells north and east of the Federal Courthouse (H-MW7 through H-MW15 on Figure 2-1) to assess the extent of the plume.

Additional groundwater monitoring was conducted in 2009-2010. Based on data from the most recent sampling event (December 2010), it is apparent that the Howe PCE plume has migrated east of the Federal Courthouse Building.

2.3.3 Indoor Air Sampling 2010 and 2011

As part of the supplemental monitoring to provide current data to assess impacts from the PCE groundwater plume, Ecology directed UW to evaluate the Federal Courthouse Building indoor air for the presence of PCE and its breakdown products. UW conducted an indoor air study that included collecting and analyzing six indoor air samples and one outdoor background air sample. This sampling at the Federal Courthouse was conducted on December 9, 2010. In 2011, a reassessment of the indoor quality within the University Bookstore building (Figure 2-1) was conducted at UW's request to supplement previous indoor testing conducted as part of the RI in 2001. On May 1, 2011, five indoor air samples and one outdoor background air sample were collected within the University Bookstore and analyzed for PCE and its breakdown products. The results of these two air sampling events are summarized in Section 4.

Table 2-1
Summary of Groundwater Elevations
Former Howe Parcel, UW Tacoma

H-MW1	Date	TOC Elev.(ft.)	DTW(ft.)	GW Elev.(ft.)
TD (ft.): 27	01-Oct-98	48.23	15.97	32.26
Screen Elev.(ft. NGVD 29): 36 to 21	01-Jan-99	48.23	14.7	33.53
	28-Jan-99	48.23	14.14	34.09
	01-Apr-99	48.23	14.88	33.35
	01-Sep-99	48.23	15.81	32.42
	01-Nov-99	48.23	15.43	32.80
	01-Apr-00	48.23	14.39	33.84
	01-Sep-00	48.23	16.31	31.92
	May-01	48.23	15.85	32.38
	Jul-08	48.23	13.93	34.30
	Feb-09	48.23	13.30	34.93
	09-May-09	48.23	13.30	34.93
	27-May-09	48.23	13.08	35.15
	10-Dec-10	48.23	12.92	35.31

H-MW2	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.): 30	01-Oct-98	48.58	22.97	25.61
Screen Elev. (ft. NGVD 29): 33 to 19	01-Jan-99	48.58	21.64	26.94
	28-Jan-99	48.58	21.29	27.29
	01-Apr-99	48.58	21.71	26.87
	01-Sep-99	48.58	22.57	26.01
	01-Nov-99	48.58	22.56	26.02
	01-Apr-00	48.58	21.24	27.34
	01-Sep-00	48.58	22.18	26.40
	May-01	48.58	21.23	27.35
	Jul-08	48.58	21.23	27.35
	Feb-09	48.58	20.85	27.73
	09-May-09	48.58	20.76	27.82
	27-May-09	48.58	20.76	27.82
	10-Dec-10	48.58	20.75	27.83

H-MW3	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.): 41	01-Oct-99	49.02	28.5	20.52
Screen Elev. (ft. NGVD 29): 23 to 8	01-Nov-99	49.02	28.46	20.56
	01-Apr-00	49.02	28.15	20.87
	01-Sep-00	49.02	28.39	20.63
	May-01	49.02	28.12	20.90
	Jul-08	49.02	28.23	20.79
	Feb-09	49.02	27.99	21.03
	09-May-09	49.02	28.03	20.99
	27-May-09	49.02	27.98	21.04
	10-Dec-10	49.02	28.00	21.02

H-MW4	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.): 38	01-Oct-99	49.06	29.76	19.30
Screen Elev. (ft. NGVD 29): 31 to 11	01-Nov-99	49.06	29.72	19.34
	01-Apr-00	49.06	29.57	19.49
	01-Sep-00	49.06	29.7	19.36
	May-01	49.06	29.5	19.56
	Jul-08	49.06	29.55	19.51
	Feb-09	49.06	29.36	19.70
	09-May-09	49.06	29.45	19.61
	27-May-09	49.06	29.35	19.71
	10-Dec-10	49.06	29.30	19.76

H-MW5	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.): 41	01-Apr-00	50.20	30.95	19.25
Screen Elev. (ft. NGVD 29): 24 to 9	01-Sep-00	50.20	31.08	19.12
	May-01	50.20	30.93	19.27
	Jul-08	50.20	31.07	19.13
	Feb-09	50.20	30.81	19.39
	09-May-09	50.20	30.85	19.35
	27-May-09	50.20	30.81	19.39
	10-Dec-10	50.20	30.76	19.44

Table 2-1
Summary of Groundwater Elevations
Howe Parcel, UW Tacoma

H-MW6	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.): 15	01-Apr-00	21.50	3.28	18.22
Screen Elev.(ft. NGVD 29): 16.5 to 6.5	01-Sep-00	21.50	3.7	17.80
	May-01	21.50	2.99	18.51
	Jul-08	21.50	3.33	18.17
	09-Feb-09	21.50	3.12	18.38
	09-May-09	21.50	2.94	18.56
	28-May-09	21.50	3.07	18.43
	09-Dec-10	21.50	2.73	18.77

H-MW7	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.): 15	Jul-08	19.82	2.32	17.50
Screen Elev. (ft. NGVD 29): 15.1 to 5.1	Feb-09	19.82	2.15	17.67
	09-May-09	19.82	1.95	17.87
	28-May-09	19.82	1.19	18.63
	09-Dec-10	19.82	1.78	18.04

H-MW8	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.): 15	Jul-08	20.74	1.48	19.26
Screen Elev. (ft. NGVD 29): 16.0 to 6.0	Feb-09	20.74	1.03	19.71
	09-May-09	20.74	0.95	19.79
	27-May-09	20.74	0.99	19.75
	09-Dec-10	20.74	1.02	19.72

H-MW9	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.): 25	Jul-08	20.64	1.7	18.94
Screen Elev. (ft. NGVD 29): 5.9 to -4.1	Feb-09	20.64	1.37	19.27
	09-May-09	20.64	1.26	19.38
	28-May-09	20.64	1.31	19.33
	09-Dec-10	20.64	1.13	19.51

H-MW10	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.): 15	Jul-08	20.69	2.16	18.53
Screen Elev. (ft. NGVD 29): 15.9 to 5.9	Feb-09	20.69	1.81	18.88
	09-May-09	20.69	1.72	18.97
	28-May-09	20.69	1.79	18.90
	09-Dec-10	20.69	1.60	19.09

H-MW11	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.):25	09-Apr-09	19.31	1.23	18.08
Screen Elev.(ft. NGVD 29): 4.6 to -5.4	09-May-09	19.31	1.18	18.13
	28-May-09	19.31	1.27	18.04
	09-Dec-10	19.31	1.18	18.13

H-MW12	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.): 15	09-Apr-09	19.18	1.41	17.77
Screen Elev. (ft. NGVD 29): 14.6 to 4.6	09-May-09	19.18	1.34	17.84
	28-May-09	19.18	1.41	17.77
	09-Dec-10	19.18	1.44	17.74

H-MW13	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.): 15	09-Apr-09	19.09	2.38	16.71
Screen Elev. (ft. NGVD 29): 14.6 to 4.6	09-May-09	19.09	2.36	16.73
	28-May-09	19.09	2.38	16.71
	09-Dec-10	19.09	2.12	16.97

H-MW14	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.): 25	09-Apr-09	21.79	6.94	14.85
Screen Elev. (ft. NGVD 29): 7.1 to -2.9	09-May-09	21.79	6.89	14.90
	28-May-09	21.79	6.92	14.87
	09-Dec-10	21.79	6.64	15.15

H-MW15	Date	TOC Elev.(ft.)	DTW	GW Elev.(ft.)
TD (ft.): 15	09-Apr-09	21.69	7.12	14.57
Screen Elev. (ft. NGVD 29): 17.2 to 7.2	09-May-09	21.69	7.06	14.63
	28-May-09	21.69	7.06	14.63
	09-Dec-10	21.69	6.82	14.87

DTW – depth to water
GW – groundwater
NGVD – National Geodetic Vertical Datum
TOC – top of casing
TD – total depth

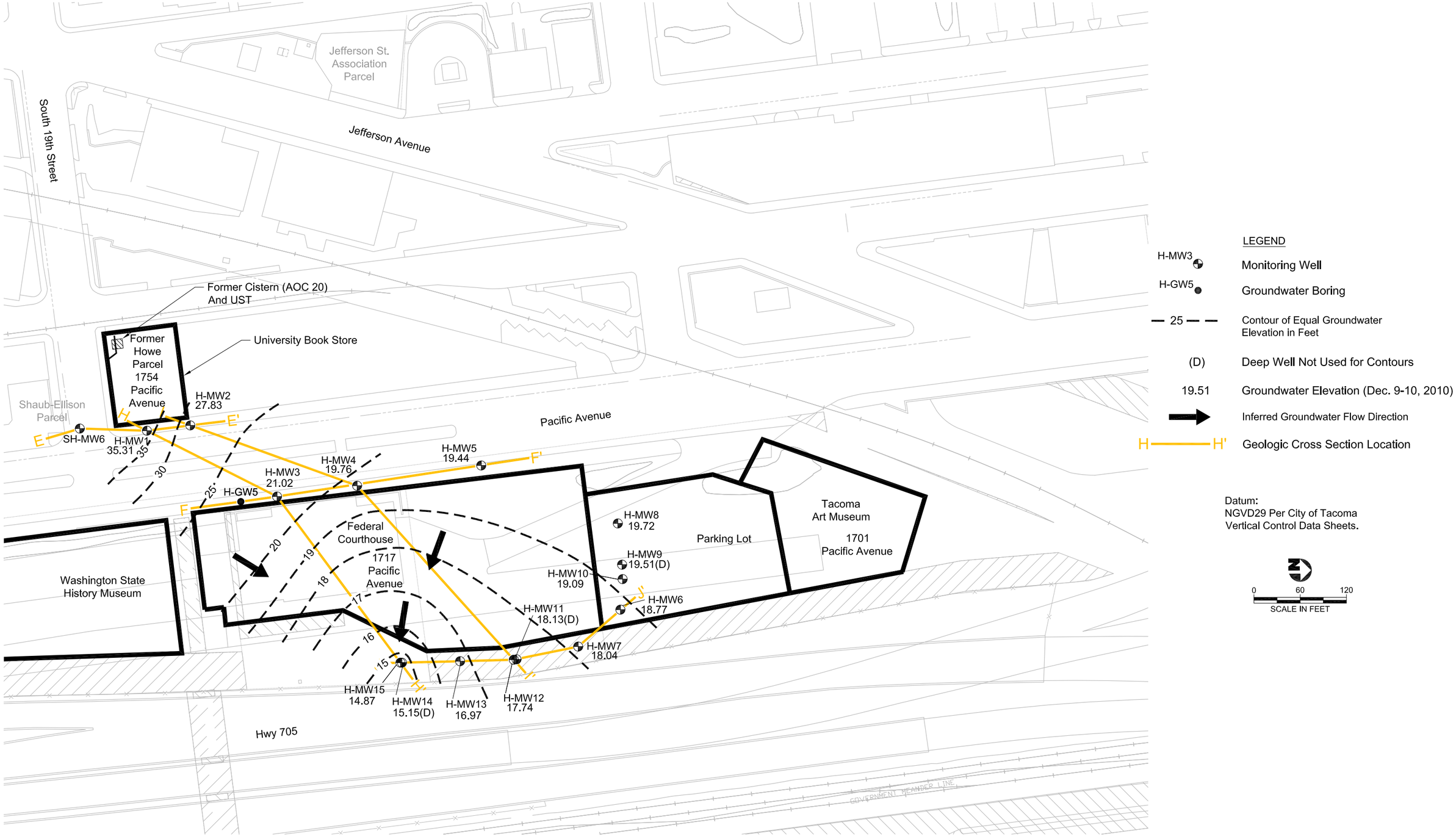

Figure 2-1

Geologic Cross-Section Location and Groundwater Elevation Contour Map

Job No. 33762555

URS

P:\ACAD\PROJECT\UW-Tac\Campus\Work Plan\Interim Action\Figure 2-1 Geo X GW..dwg
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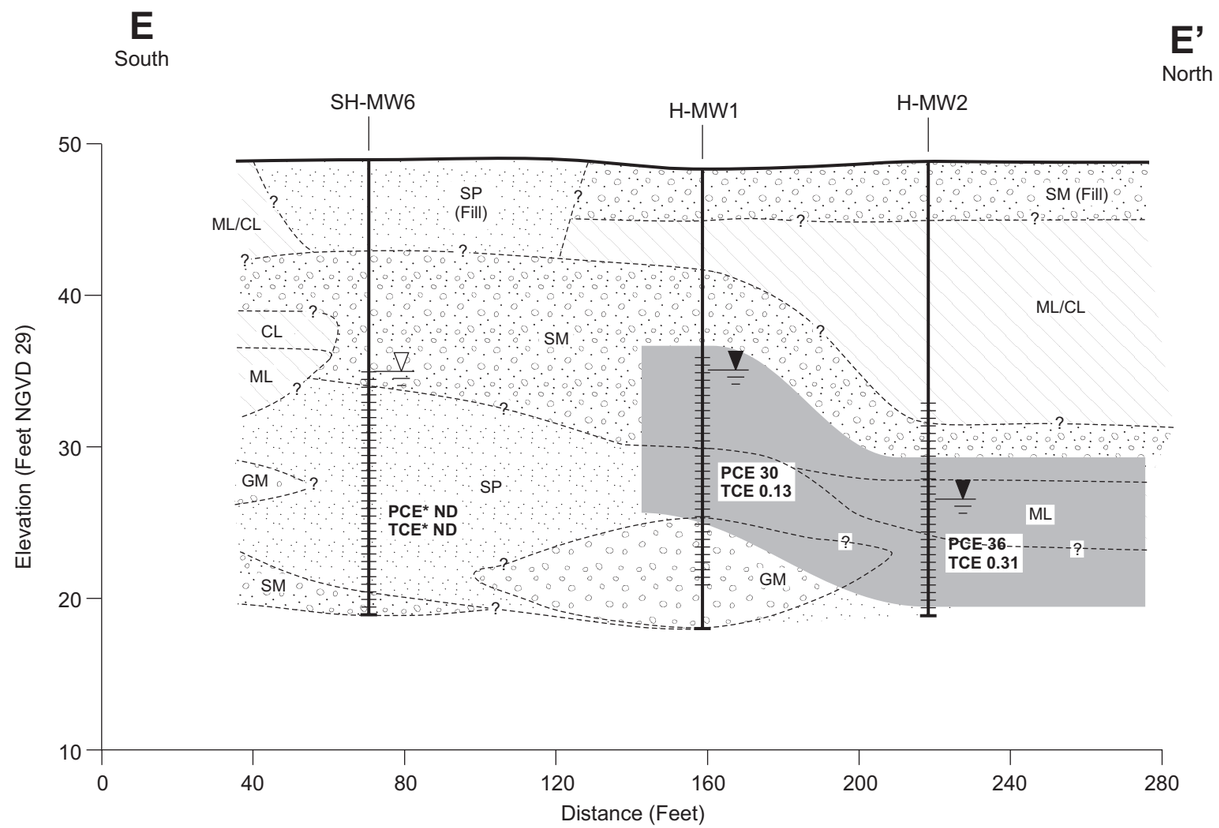
University of Washington Tacoma Campus
Howe Parcel
INTERIM ACTION WORKPLAN

33762555_18.cdr



LEGEND

Groundwater elevation (approximate)	SM	Silty, fine to medium sand with occasional gravel	ML, CL, ML/CL
Groundwater elevation December 9-10, 2010	SP	Fine to medium sand with occasional gravel	SM
Inferred geologic formation contact, queried where uncertain	GP	Sandy gravel (pea gravel in fill)	GM
SH-MW8 Monitoring well location and number	ML	Silt	SP, GP, GP/SP, SP/GP
SH-GW3 Soil boring location and number	CL	Silty clay	Target treatment zone
	GM	Silty gravel	

0 40 80

Horizontal Scale in Feet
Vertical Exaggeration = 4x

NOTE

TCE = Trichloroethene

PCE = Tetrachloroethene

ND = Not detected

Units in g/L

Groundwater sampled December 2010

*Sampled January 2008 - May 2009

Job No. 33762555

Figure 2-2
Geologic Cross Section E-E'

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Howe Parcel
INTERIM ACTION WORKPLAN

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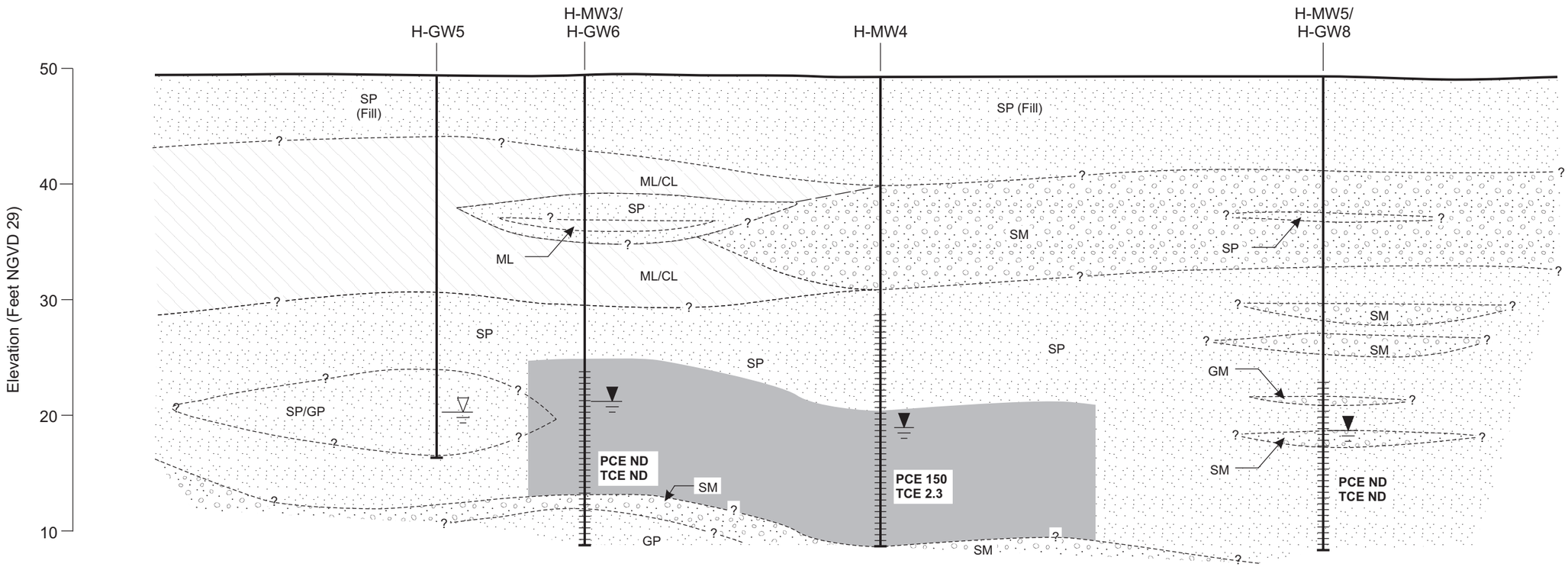
F
South

F'
North



LEGEND

Groundwater elevation (approximate)	SM	Silty, fine to medium sand with occasional gravel	ML, CL, ML/CL
Groundwater elevation December 9-10, 2010	SP	Fine to medium sand with occasional gravel	SM
Inferred geologic formation contact, queried where uncertain	GP	Sandy gravel (pea gravel in fill)	GM
SH-MW8 Monitoring well location and number	ML	Silt	SP, GP, GP/SP, SP/GP
SH-GW3 Soil boring location and number	CL	Silty clay	Target treatment zone
	GM	Silty gravel	

0 40 80
Horizontal Scale in Feet
Vertical Exaggeration = 4x

NOTE

TCE = Trichloroethene

PCE = Tetrachloroethene

ND = Not detected

Units in g/L

Groundwater sampled December 2010

Job No. 33762555

Figure 2-3
Geologic Cross Section F-F'

URS

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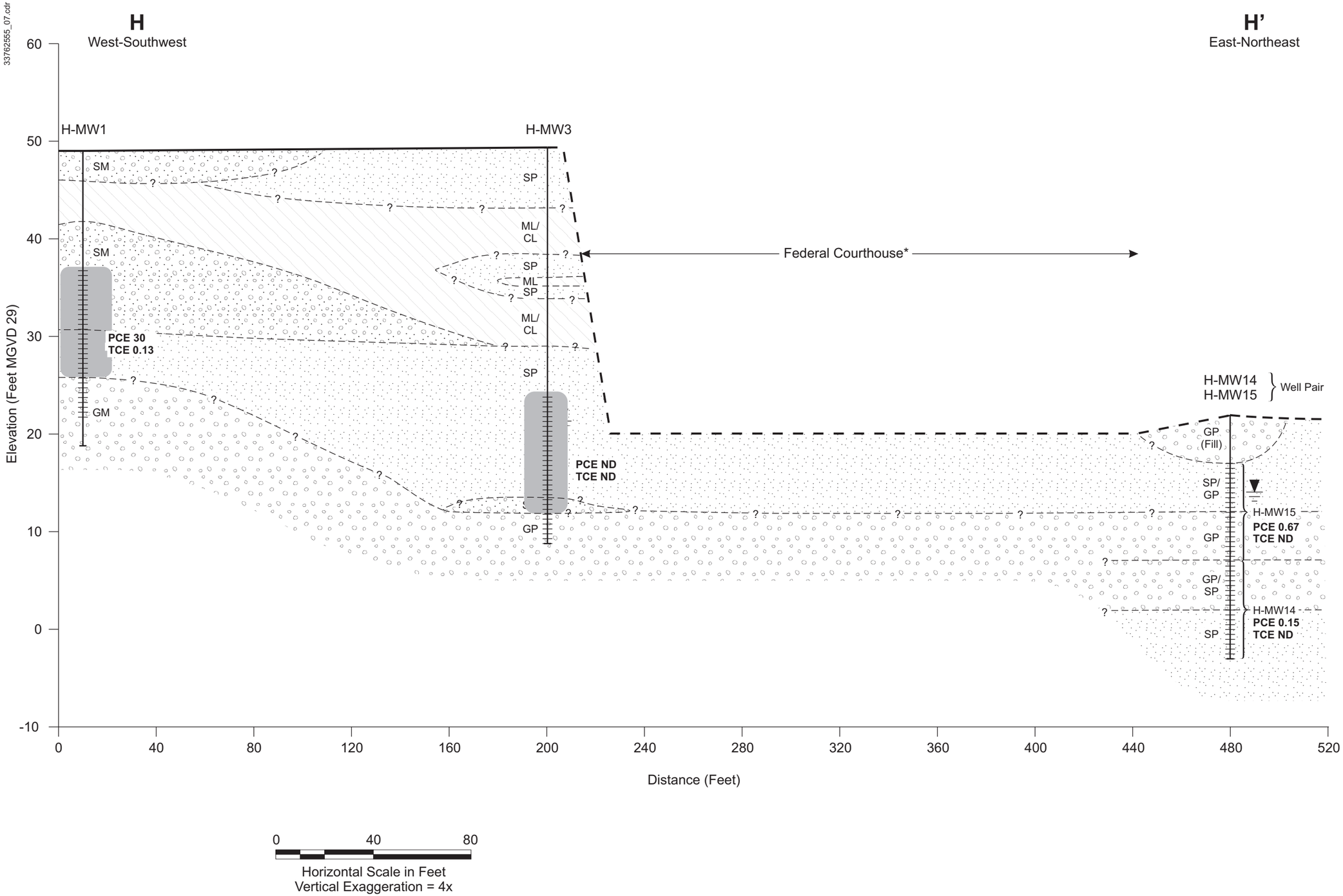
Howe Parcel
INTERIM ACTION WORKPLAN

33762555_07.cdr



LEGEND

- Groundwater elevation (approximate)
- Groundwater elevation May 27-28, 2009
- Inferred geologic formation contact, queried where uncertain
- Approximate building grade
- SH-MW8 Monitoring well location and number
- SH-GW3 Soil boring location and number
- SM Silty, fine to medium sand with occasional gravel
- SP Fine to medium sand with occasional gravel
- GP Sandy gravel (pea gravel in fill)
- ML Silt
- CL Silty clay
- GM Silty gravel
- ML, CL, ML/CL
- SM
- GM
- SP, GP, GP/SP, SP/GP
- Target treatment zone

NOTE

TCE = Trichloroethene
PCE = Tetrachloroethene
ND = Not detected
* = Ground floor elevation ~ 20 feet

Units in g/L

Groundwater sampled December 2010

Figure 2-4

Geologic Cross Section H-H'

Job No. 33762555

URS

University of Washington, Tacoma Campus
Howe Parcel
INTERIM ACTION WORKPLAN

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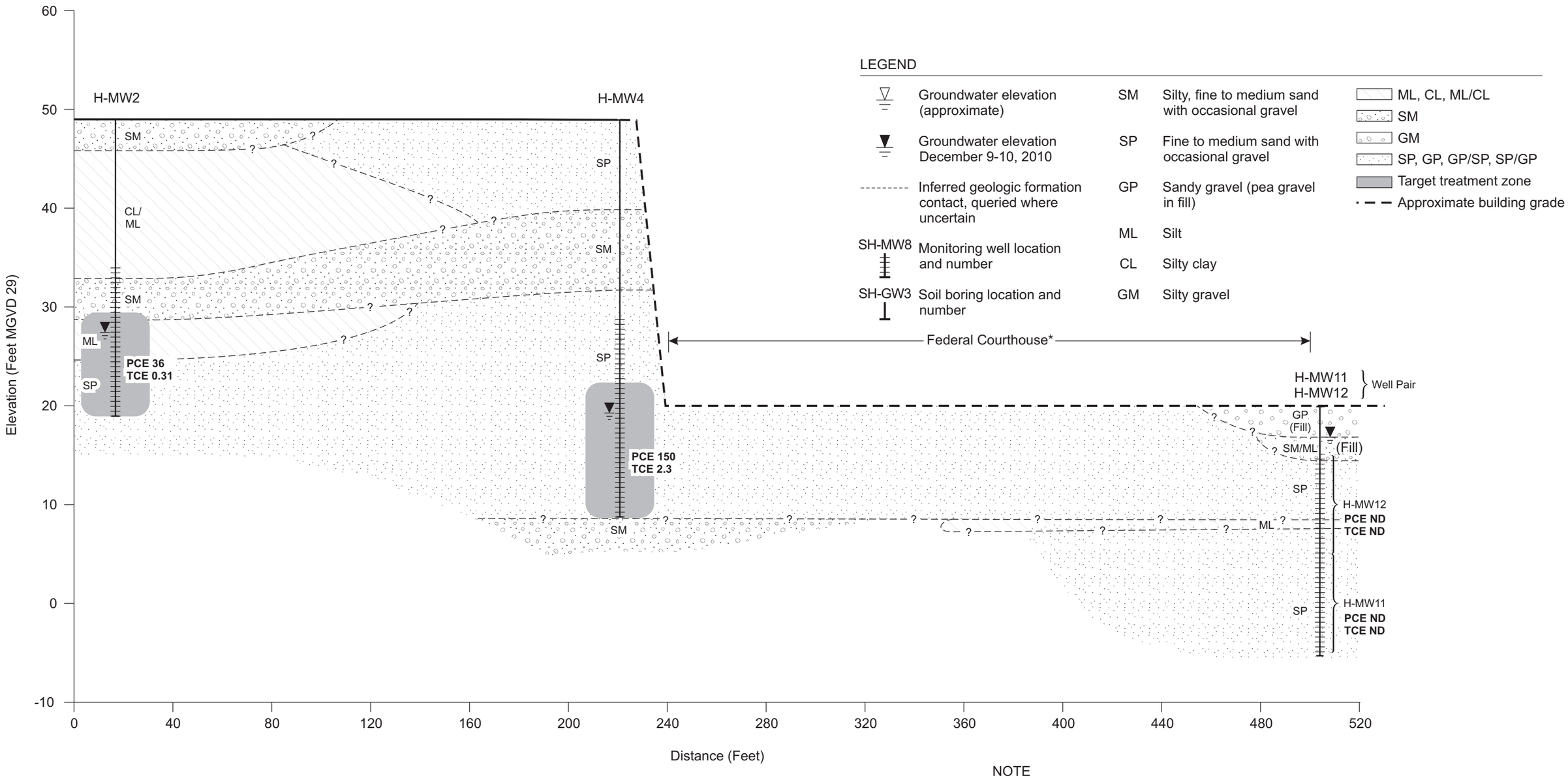
I
West-Southwest

I'
East-Northeast



LEGEND

Groundwater elevation (approximate)	SM	Silty, fine to medium sand with occasional gravel	ML, CL, ML/CL
Groundwater elevation December 9-10, 2010	SP	Fine to medium sand with occasional gravel	SM
Inferred geologic formation contact, queried where uncertain	GP	Sandy gravel (pea gravel in fill)	GM
SH-MW8 Monitoring well location and number	ML	Silt	SP, GP, GP/SP, SP/GP
SH-GW3 Soil boring location and number	CL	Silty clay	Target treatment zone
	GM	Silty gravel	Approximate building grade

0 40 80
Horizontal Scale in Feet
Vertical Exaggeration = 4x

NOTE

TCE = Trichloroethene
PCE = Tetrachloroethene
ND = Not detected
* = Ground floor elevation ~ 20 feet

Units in g/L
Groundwater sampled December 2010

Job No. 33762555

Figure 2-5
Geologic Cross Section I-I'

URS

University of Washington, Tacoma Campus
Howe Parcel
INTERIM ACTION WORKPLAN

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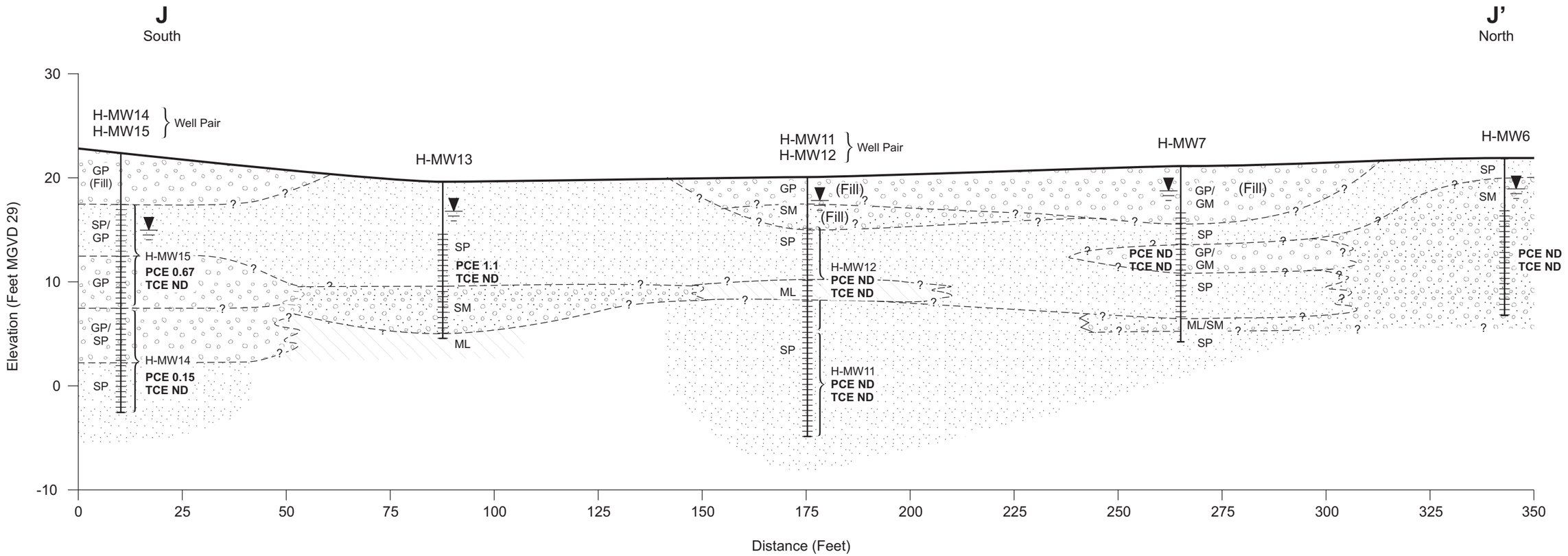


0 25 50

Horizontal Scale in Feet
Vertical Exaggeration = 2.5x

LEGEND

- Groundwater elevation (approximate)
- Groundwater elevation December 9-10, 2010
- Inferred geologic formation contact, queried where uncertain
- SH-MW8 Monitoring well location and number
- SH-GW3 Soil boring location and number

- SM Silty, fine to medium sand with occasional gravel
- SP Fine to medium sand with occasional gravel
- GP Sandy gravel (pea gravel in fill)
- ML Silt
- CL Silty clay
- GM Silty gravel

- ML, CL, ML/CL
- SM
- GM
- SP, GP, GP/SP, SP/GP

NOTE

TCE = Trichloroethene

PCE = Tetrachloroethene

ND = Not detected

Units in g/L

Groundwater sampled December 2010

Job No. 33762555

Figure 2-6

Geologic Cross Section J-J'

URS

University of Washington, Tacoma Campus
Howe Parcel
INTERIM ACTION WORKPLAN

3.0 INTERIM ACTION CLEANUP LEVELS AND ACTION LEVELS

3.1 CONTAMINANTS OF POTENTIAL CONCERN

Table 3-1 identifies the COPCs and IA cleanup and action levels for groundwater.

3.2 GROUNDWATER INTERIM ACTION CLEANUP LEVELS

IA cleanup levels for the Howe PCE plume are described below. The IA cleanup levels apply only to the interim groundwater remedial action for the Howe PCE plume. Final cleanup levels for the UW Tacoma Campus Site will be determined by Ecology upon approval of the cleanup action plan for the entire Site.

The objective of the IA is to reduce VOC concentrations in groundwater to IA cleanup levels. The IA cleanup levels are current MTCA Method A groundwater cleanup levels for the COPC constituents with established Method A levels. These are PCE, TCE and vinyl chloride. Method B levels will be used as a measure for those constituents that do not have established Method A cleanup levels to monitor the progress of the IA such as evaluating the IA for changes in degradation product concentrations and determining action levels that trigger an additional action.

3.3 GROUNDWATER POINT OF COMPLIANCE

Groundwater points of compliance for the UW Tacoma Campus Site, including the Howe Parcel PCE plume, will be established in the cleanup action plan for the entire Site.

3.4 APPLICABLE STATE AND FEDERAL LAWS

The IA will be conducted under an Agreed Order with Ecology. Consequently, the remedial action is exempt from the procedural requirements of certain laws and all local permits (WAC 173-340-710(9)(a)) but must comply with the substantive requirements of these laws and permits. The exemption from procedural requirements applies to the following:

- Washington Clean Air Act (RCW 70.94)
- Solid Waste Management Act (RCW 70.95)
- Hazardous Waste Management Act (RCW 70.105)
- Construction Projects in State Waters (RCW 75.55)
- Water Pollution Control Act (RCW 90.48)
- Shoreline Management Act (RCW 90.58)
- Any laws requiring or authorizing local government permits or approvals for the remedial action.

The exemption is not applicable if Ecology determines that the exemption would result in the loss of approval from a Federal agency that may be necessary for the State to administer a Federal law. The required and exempt permit requirements/approvals are provided in the following section.

3.4.1 Required Permits/Approvals

The following permits/approvals are applicable to the IA and do not fall under the procedural exemption of WAC 173-340-710(9)(a):

- Washington State Well Construction Permits
- Requirements to Operate an Underground Injection Control (UIC) Well, WAC 173-218-060 (5)(b).

3.4.2 Applicable Substantive Requirements (Exempt Permits)

The applicable substantive requirements of the following exempt permits or approvals (as identified at the time of this IAWP) will be more particularly identified as necessary during each phase of the IA cleanup:

- City of Tacoma Street Use Permit (including traffic control and well installations). Permits will have to be obtained from the City of Tacoma for installing wells and temporary direct push injection borings in the right-of-way. Additionally, an encroachment permit/side walk closure permit will need to be obtained from the City to close the sidewalk and nearby parking spaces during well installations and injection events. A traffic control plan will need to be prepared, submitted to and approved by the City, and implemented.
- Washington State Dangerous Waste Regulations (WAC 173-303). Disposal of investigative derived waste that is generated as part of this interim action will need to comply with the applicable Washington State Dangerous Waste Regulations.
- Federal and State of Washington Worker Safety Regulations (WAC Chapters 296-24, 296-62, and 296-155 and Occupational Safety and Health Act (OSHA) 29 CFR Part 1910.120. OSHA 40 hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training is a requirement of workers that have the potential to be exposed to hazardous substances as part of this interim action.

3.5 GROUNDWATER ACTION LEVELS

Action levels will be used for this IA to determine whether additional groundwater remediation is required to prevent further migration of COPCs downgradient of the Federal Courthouse property.

A groundwater action level of 75% of the IA cleanup level, as appropriate, for the COPCs (Table 3-1) will be established at the downgradient wells on the courthouse property (H-MW11 through H-MW15). This action level criterion was determined in consultation with Ecology and is intended to be sufficiently below the IA cleanup level to allow the implementation of additional corrective measures before an IA cleanup level is exceeded. If future compliance monitoring data indicate that groundwater concentrations exceed an applicable action level in two consecutive samples, then UW will propose additional groundwater remediation measures for Ecology review and approval, to mitigate further migration of COPCs in groundwater above action levels beyond the Federal Courthouse property.

The following actions will be implemented in the event that groundwater action levels are exceeded in one or more well(s) located downgradient of the Federal Courthouse building.

- Notify Ecology within 10 days of receiving the analytical report that indicates that an action level is exceeded.
- Resample the affected well(s) within 30 days of receiving the analytical report that indicates an action level is exceeded.
- If resampling confirms that one or more COPC concentrations are above applicable action levels, but below applicable IA cleanup levels, then the groundwater monitoring frequency of the affected well(s) will be increased from quarterly to monthly until a trend can be established (i.e., at least three consecutive sampling events). If groundwater COPC concentration trends indicate that IA cleanup levels will not likely be exceeded, then groundwater monitoring frequency may be reduced in consultation with Ecology.
- If resampling confirms that IA action levels are exceeded and IA cleanup levels are likely be exceeded based on increasing trends in COPC concentrations, then submit a plan to Ecology proposing further remedial measures in the area east of the Federal Courthouse within 30 days of receiving the confirming analytical results.

Implement additional IA remedial measures (i.e., additional injections at Federal Courthouse property or other Ecology-approved measures) within 60 days of receiving Ecology approval. Based on the hydraulic gradient and other site-specific factors, the estimated time for PCE in groundwater to travel from the sentry well (H-MW-11 through H-MW-15) to the downgradient property line on the courthouse property is approximately 2.7 years. Appendix B provides a calculation of the PCE travel time, including input parameters, calculated values, and assumptions. The calculation presented in Appendix B suggests that there should be sufficient time to implement the above contingency actions before groundwater contaminants migrate downgradient of the courthouse property at concentrations above the IA cleanup levels.

Table 3-1
Principal COPCs and Concentration Ranges above IA Cleanup Levels
Former Howe Parcel, UW Tacoma

	Groundwater				
Contaminant of Potential Concern	**MTCA Method A Level (µg/L)**	**MTCA Method B Level (µg/L)**	**IA Cleanup Levelb (µg/L)**	**IA Action Levelc (µg/L)**	**Concentration Range Detected Above MTCA and IA Cleanup Leveld (µg/L)**
PCE	5.0	NA	5.0	3.75	6.57–311
TCE[a]	5.0	NA	5.0	3.75	5.49–12
cis-1,2 DCE[a]	NA	16	NA	12	NA
trans-1,2 DCE[a]	NA	160	NA	120	NA
1,1-DCE[a]	NA	400	NA	300	NA
Vinyl Chloride[a]	NA	0.2	NA	0.15	NA

Notes:
a. Potential degradation product from PCE.
b. Applicable IA cleanup level for Howe Parcel PCE Plume is MTCA Method A
c. IA action level is 75-percent of IA cleanup level or 75-percent of MTCA Method B level if there is no established Method A level
d.Concentration range includes data from groundwater samples collected from monitoring wells and borings (grab and probe samples).
µg/L–micrograms per liter
DCE–dichloroethene
MTCA–Model Toxics Control Act
NA-not applicable
PCE – tetrachloroethene
TCE–trichloroethene

4.0 NATURE AND EXTENT OF CONTAMINATION

This section discusses the nature and extent of contamination at the former Howe Parcel based on the prior remedial investigations (URS 2002) and subsequent investigation and monitoring of groundwater for the interim action assessment for the Howe PCE plume.

4.1 SOIL

Water containing PCE was detected during removal of a cistern and associated piping at the former Howe Parcel and is the probable source of PCE release to groundwater on the former Howe Parcel. However, no soil samples were collected and analyzed for PCE during the cistern removal, which occurred in May 1996. Due to the active bookstore operations, this area was not accessible to direct investigation of PCE concentrations in vadose zone soil beneath the building.

4.2 GROUNDWATER

The nature and extent of PCE and TCE in groundwater emanating from beneath the former Howe Parcel on the UW Tacoma Campus is documented in the draft RI report (URS 2002) and subsequent assessment of groundwater for the interim actions for the Howe PCE plume. All laboratory analytical results for groundwater in the area of the Howe PCE plume are summarized in Tables 4-1 through 4-4. The data obtained to date indicate a plume of PCE in groundwater extends from beneath the former Howe Parcel to the east across Pacific Ave. and beneath the Federal Courthouse building (Figure 4-1).

Based on vertical groundwater profiling in the sidewalk adjacent to the University Bookstore (boring H-GW4 adjacent to monitoring well H-MW2), the vertical extent of PCE in groundwater appears to be limited to the uppermost 10 feet of groundwater. The depth to groundwater at this location is typically approximately 22 feet bgs. PCE was detected in H-GW4 at depths of 22 feet and 27 feet bgs, but was not detected at 32 feet bgs. The highest PCE concentration was in the sample from 22 feet bgs. A similar decrease in PCE concentration with depth was detected in the uppermost approximately 5 feet of groundwater at H-GW6 (monitoring well H-MW3); however, drilling refusal precluded collection of a deeper sample. In addition, TCE was detected at a depth of 31 feet in H-GW7 but was not detected at 43 feet bgs. Well H-GW7 was located approximately mid-way between wells H-MW4 and H-MW5.

The most recent groundwater sampling results (December 2010) indicate PCE concentrations of 36 µg/L and 150 µg/L in the central portion of the plume (wells H-MW2 and H-MW4, respectively). Low PCE concentrations (less than 2 µg/L) were detected in downgradient wells H-MW13, H-MW14, and H-MW15 (Figure 4-1). Figures 4-2 and 4-3 show the change in PCE concentrations over time in wells H-MW1 through H-MW4 with data from 1999 through 2010.

4.3 AIR

The presence of VOCs in soil and groundwater at or near the former Howe Parcel suggest the potential for air-related exposures in occupied spaces and surface releases from the ground surface in areas underlain by the Howe PCE plume. Vapor phase migration of volatile constituents can occur from contaminated soils and groundwater upward to the ground surface or into overlying buildings. Surface exposures are not considered a significant exposure pathway because of the impervious nature of much of the former Howe Parcel and vicinity's surfaces, as well as the rapid dilution and dispersion that occurs in the atmosphere. Additionally, the soil and groundwater contamination is largely located at depth, well below the ground surface.

Indoor air testing was performed at the Federal Courthouse building in December 2010 at the locations shown on Figure 4-4 to evaluate the potential vapor intrusion pathway from the underlying PCE groundwater plume. The samples were collected in general accordance with the Supplemental Work Plan, Indoor Air and Groundwater Sampling, which was approved by Ecology (URS 2010b). Table 4-5 summarizes 2010 indoor air sampling results at the Federal Courthouse. The results show elevated levels of PCE (a maximum concentration of 8.4 µg/m3 at FC-3) and TCE (a maximum concentration of 0.24 µg/m3 at FC2) at the ground floor level of the courthouse (Figure 4-4), which suggests that the vapor intrusion may be occurring at the courthouse. While indoor air test results from samples collected at the Federal Courthouse were above applicable MTCA Method B indoor air cleanup levels for PCE and TCE, the levels did not exceed action levels that would require immediate action. Federal Courthouse Building indoor air sampling results and laboratory reports were provided to Ecology in Technical Memorandum #8 (URS 2011a). Indoor air action levels were established and discussed in Technical Memorandum #9 (URS 2011b).

Indoor air testing was performed in the University Bookstore building in May 2011 to evaluate the potential vapor intrusion pathway. The samples were collected using similar procedures as the previous indoor air sampling event at the Federal Courthouse. Five indoor air samples and one outdoor background air sample were collected at the locations shown on Figure 4-5. Table 4-6 summarizes the 2011 indoor air sample results in the University Bookstore. The results indicate PCE and other chlorinated VOCs were not detected in any of the samples from publically-accessible areas in the University Bookstore. TCE was detected once above the MTCA Method B indoor air cleanup level in a sample collected in the southwest portion of a utility tunnel. The utility tunnel is rarely occupied by UW personnel and is not accessible to the general public. The detected TCE concentration in the utility tunnel (1.4 µg/m3) was below the action level of 3 µg/m3 for TCE that would require immediate action in an occupied area. The indoor air sampling results and laboratory reports were provided to Ecology in Technical Memorandum #10 (URS 2011c). Indoor air sampling in May 2011 may not be representative of worst case conditions which are presumed to occur during the winter months. If additional indoor air monitoring is performed in the University Bookstore, it will be conducted during the winter to assess potential worst case conditions.

Table 4-1
Summary of Groundwater Analytical Results for Volatile Organic Compounds
Former Howe Parcel, UW Tacoma
(µg/L)

Sample ID	Sample Date	PCE	TCE	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	Vinyl chloride
H-MW1	10/26/1998	1.00 U	1.00 U	NA	1.00 U	NA	NA
	1/12/1999	1.00 U	1.00 U	NA	1.00 U	NA	NA
	4/20/1999	1.00 U	1.00 U	NA	1.00 U	NA	NA
	4/20/1999 (DUP)	1.00 U	1.00 U	NA	1.00 U	NA	NA
	9/8/1999	1.00 U	1.00 U	NA	1.00 U	NA	NA
	7/2/2008	**28.3**	0.260 J	0.0500 U	0.200 U	0.200 U	0.0200 U
	2/5/2009	**22.5**	0.190	0.0500 U	0.200 U	0.200 U	0.0200 U
	5/27/2009	**26.2**	0.260	0.0500 U	0.0800	0.100 U	0.0200 U
	12/10/2010	**30**	0.13	0.050 U	0.050 U	0.10 U	0.020 U
H-MW2	10/26/1998	**246**	1.00 U	NA	1.00 U	NA	NA
	1/12/1999	**188**	1.00 U	NA	1.00 U	NA	NA
	4/20/1999	**185**	1.00 U	NA	1.00 U	NA	NA
	9/8/1999	**254**	1.00 U	NA	1.00 U	NA	NA
	9/8/1999	**249**	**1.01**	NA	1.00 U	NA	NA
	4/3/2000	**210**	**1.12**	NA	1.00 U	NA	NA
	9/6/2000	**186**	1.00 U	NA	1.00 U	NA	NA
	7/2/2008	**118**	**0.590**	0.200 U	0.200 U	0.200 U	0.200 U
	7/2/2008 (DUP)	**112**	**0.550**	0.200 U	0.200 U	0.200 U	0.200 U
	2/5/2009	**76.0**	0.480	0.0500 U	2.00 U	2.00 U	0.0200 U
	2/5/2009 (DUP)	**80.6**	0.460	0.0500 U	2.00 U	2.00 U	0.0200 U
	5/27/2009	**50.9**	0.460	0.0500 U	0.0800	0.100 U	0.0200 U
	12/10/2010	**36**	0.31	0.050 U	0.050 U	0.10 U	0.020 U
H-MW3	10/26/1999	1.00 U	1.00 U	NA	1.00 U	NA	NA
	4/6/2000	**6.57**	1.00 U	NA	1.00 U	NA	NA
	9/7/2000	1.00 U	1.00 U	NA	1.00 U	NA	NA
	7/3/2008	**9.97**	0.370 J	0.0500 U	NA	NA	0.0200 U
	2/5/2009	**1.10**	0.0500	0.0500 U	0.200 U	0.200 U	0.0200 U
	5/27/2009	**0.0900**	0.0500 U	0.0500 U	0.0500 U	0.100 U	0.0200 U
	12/10/2010	0.050 U	0.050 U	0.050 U	0.050 U	0.10 U	0.020 U
H-MW4	10/26/1999	**311**	**9.03**	NA	4.92	NA	NA
	4/6/2000	**228**	**6.20**	NA	2.75	NA	NA
	9/7/2000	**261**	**5.49**	NA	2.48	NA	NA
	7/2/2008	**56.4**	**1.27**	0.200 U	0.260	0.200 U	0.200 U
	2/5/2009	**154**	**2.60**	0.0500 U	0.560	0.200 U	0.0200 U
	5/27/2009	**137**	**2.81**	0.0500 U	0.660	0.100 U	0.0200 U
	5/27/2009 (DUP)	**144**	**2.93**	0.0500 U	0.690	0.100 U	0.0200 U
	12/10/2010	**150 J**	**2.3**	0.050 U	0.60	0.10 U	0.020 U
H-MW5	4/6/2000	1.00 U	1.00 U	NA	1.00 U	NA	NA
	9/5/2000	1.00 U	1.00 U	NA	1.00 U	NA	NA
	7/3/2008	0.0500 U	0.0500 U	0.0500 U	NA	NA	0.0200 U
	2/5/2009	0.0500 U	0.0500 U	0.0500 U	0.200 U	0.200 U	0.0200 U
	5/27/2009	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.100 U	0.0200 U
	12/10/2010	0.050 U	0.050 U	0.050 U	0.050 U	0.10 U	0.020 U
MTCA Method A or B Groundwater Cleanup Levels		5 (A) 0.081 (B)	5 (A) 0.49 (B)	400 (B)	80 (B)	160 (B)	0.2 (A) 0.029 (B)

Table 4-1
Summary of Groundwater Analytical Results for Volatile Organic Compounds
Former Howe Parcel, UW Tacoma
(µg/L)

Sample ID	Sample Date	PCE	TCE	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	Vinyl chloride
H-MW6	4/6/2000	1.00 U	1.00 U	NA	1.00 U	NA	NA
	9/5/2000	1.00 U	1.00 U	NA	1.00 U	NA	NA
	1/4/2008 [a]	0.0500 UJ	0.0500 UJ	0.0500 UJ	0.0500 UJ	0.100 UJ	0.0200 UJ
	1/4/2008 [b]	0.0500 UJ	0.0500 UJ	0.0500 UJ	0.0500 UJ	0.100 UJ	0.0200 UJ
	7/2/2008	0.130 U	0.0500 U	0.0500 U	0.200 U	0.200 U	0.0200 U
	2/6/2009	0.0500 U	0.0500 U	0.0500 U	0.200 U	0.200 U	0.0200 U
	5/28/2009	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.100 U	0.0200 U
H-MW7	7/3/2008	0.0500 U	0.0500 U	0.0500 U	NA	NA	0.0200 U
	2/5/2009	0.0500 U	0.0500 U	0.0500 U	0.200 UJ	0.200 UJ	0.0200 U
	5/28/2009	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.100 U	0.0200 U
H-MW8	7/3/2008	0.0500 U	0.0500 U	0.0500 U	NA	NA	0.0200 U
	2/6/2009	0.0500 U	0.0500 U	0.0500 U	0.200 U	0.200 U	0.0200 U
	5/27/2009	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.100 U	0.0200 U
H-MW9	7/2/2008	0.0500 U	0.0500 U	0.0500 U	NA	NA	0.0200 U
	2/6/2009	0.0500 U	0.0500 U	0.0500 U	0.200 U	0.200 U	0.0200 U
	5/28/2009	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.100 U	0.0200 U
H-MW10	7/2/2008	0.0500 U	0.0500 U	0.0500 U	NA	NA	0.0200 U
	2/6/2009	0.0500 U	0.0500 U	0.0500 U	0.200 U	0.200 U	0.0200 U
	5/28/2009	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.100 U	0.0200 U
H-MW11	4/28/2009	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.100 U	0.0200 U
	5/28/2009	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.100 U	0.0200 U
	12/9/2010	0.050 U	0.050 U	0.050 U	0.050 U	0.10 U	0.020 U
H-MW12	4/28/2009	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.100 U	0.0200 U
	5/28/2009	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.100 U	0.0200 U
	12/9/2010	0.050 U	0.050 U	0.050 U	0.050 U	0.10 U	0.020 U
H-MW13	4/28/2009	**1.71**	0.0900	0.0500 U	0.0500 U	0.100 U	0.0200 U
	5/28/2009	**1.86**	0.120	0.0500 U	0.0500	0.100 U	0.0200 U
	12/9/2010	**1.1**	0.050 U	0.050 U	0.050 U	0.10 U	0.020 U
	12/9/10 (DUP)	**1.0**	0.050 U	0.050 U	0.050 U	0.10 U	0.020 U
H-MW14	4/28/2009	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.100 U	0.0200 U
	5/28/2009	**0.130**	0.0500 U	0.0500 U	0.0500 U	0.100 U	0.0200 U
	12/9/2010	**0.15**	0.050 U	0.050 U	0.050 U	0.10 U	0.020 U
MTCA Method A or B Groundwater Cleanup Levels		5 (A) 0.081 (B)	5 (A) 0.49 (B)	400 (B)	80 (B)	160 (B)	0.2 (A) 0.029 (B)

Table 4-1
Summary of Groundwater Analytical Results for Volatile Organic Compounds
Former Howe Parcel, UW Tacoma
(µg/L)

Sample ID	Sample Date	PCE	TCE	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	Vinyl chloride
H-MW15	4/28/2009	**0.550**	0.0600	0.0500 U	0.0500 U	0.100 U	0.0200 U
	4/28/09 (DUP)	**0.470**	0.0600	0.0500 U	0.0500 U	0.100 U	0.0200 U
	5/28/2009	**0.560**	0.0800	0.0500 U	0.0500 U	0.100 U	0.0200 U
	12/9/2010	**0.67**	0.050 U	0.050 U	0.050 U	0.10 U	0.020 U
MTCA Method A or B Groundwater Cleanup Levels		5 (A) 0.081 (B)	5 (A) 0.49 (B)	400 (B)	80 (B)	160 (B)	0.2 (A) 0.029 (B)

Numbers in **bold** font indicate the result meets or exceeds the most stringent MTCA cleanup level.
MTCA Cleanup Regulation, WAC 173-340. MTCA Method A and B values are from Ecology website CLARC tables downloaded January 2011 (https://fortress.wa.gov/ecy/clarc/reporting/CLARCReporting.aspx).
a. Sample collected at a depth of 5 feet below top of casing using a passive diffusion bag sampler.
b. Sample collected at a depth of 15 feet below top of casing using a passive diffusion bag sampler.
µg/L – micrograms per liter
(A) – MTCA Method A
(B) – MTCA Method B
DCE – dichloroethene
(DUP) – Field duplicate
J = Estimated concentration
MTCA – Model Toxics Control Act
NA = Not analyzed or not available
PCE – tetrachloroethene
TCE – trichloroethene
U = Compound was analyzed for but not detected above the reporting limit shown.
UJ = Compound was analyzed for but not detected above the reporting limit shown. The reported result is an estimated concentration.

Table 4-2
Summary of Groundwater Analytical Results for Dissolved Gases
Former Howe Parcel, UW Tacoma
(µg/L)

Sample ID	Sample Date	Methane	Ethane	Ethene
H-MW1	7/2/2008	1.20 U	10.0 U	10.0 U
H-MW2	7/2/2008	1.20 U	10.0 U	10.0 U
H-MW4	7/2/2008	1.20 U	10.0 U	10.0 U
H-MW6	7/2/2008	3.94	10.0 U	10.0 U

U - Compound was analyzed for but not detected above the reporting limit shown.

Samples were analyzed by *Standard Operating Procedure, Sample Preparation and Calculation for Dissolved Gas Analysis in Water Samples Using a GC Headspace Equilibrium Technique (RSK-175)* , dated August 11, 1994

Table 4-3
Summary of Groundwater Analytical Results for Total and Dissolved Metals
Former Howe Parcel, UW Tacoma
(mg/L)

		Arsenic		Calcium		Iron		Magnesium		Manganese		Potassium		Sodium	
Sample ID	Sample Date	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
H-MW1	7/2/2008	0.100 U	0.100 U	23.3	23.0	0.385	0.150 U	22.7	23.0	0.0618	0.0298	3.00 U	3.00 U	21.5	21.9
H-MW2	7/2/2008	0.100 U	0.100 U	29.9	28.6	0.150 U	0.150 U	22.3	21.8	0.0764	0.0100 U	3.73	3.76	25.8	27.2
H-MW4	7/2/2008	0.100 U	0.100 U	26.1	25.4	2.81	0.150 U	22.7	22.4	0.513	0.0100 U	3.52	3.53	22.5	24.7
H-MW6	7/2/2008	0.100 U	0.100 U	11.1	10.8	0.491	0.150 U	9.85	9.78	0.175	0.164	3.00 U	3.00 U	7.00	7.33

U - Compound was analyzed for but not detected above the reporting limit shown.

Table 4-4
Summary of Groundwater Analytical Results for Conventional Parameters
Former Howe Parcel, UW Tacoma
(mg/L)

Sample ID	Sample Date	Total Dissolved Solids	Anions			Alkalinity				Organic Carbon	
			Chloride	Nitrate	Sulfate	Total	Bicarbonate	Carbonate	Hydroxide	Total	Dissolved
H-MW1	7/2/2008	250	22.3	0.510 J	38.8	140	140	5.0 U	5.0 U	1.1	1.6
H-MW2	7/2/2008	290	26.0	0.670 J	35.4	160	160	5.0 U	5.0 U	1.2	2.2
H-MW4	7/2/2008	290	25.0	0.710 J	32.0	150	150	5.0 U	5.0 U	1.1	1.6
H-MW6	7/2/2008	140	4.83	0.200 UJ	5.82	81	81	5.0 U	5.0 U	1.0 U	1.3

J - Estimated concentration.

U - Compound was analyzed for but not detected above the reporting limit shown.

UJ - Compound was analyzed for but not detected above the reporting limit shown. The reported result is an estimated concentration.

Table 4-5
Summary of Volatile Organic Compounds in Indoor Air
UW Tacoma, Federal Courthouse

Sample ID: Sample Date: Field QC:	**MTCA Air Cleanup Levels Method B**	**Indoor Air Action Levels**	**FC-1** 12/9/2010	**FC-2** 12/9/2010	**FC-3** 12/9/2010	**FC-4** 12/9/2010	**FC-5** 12/9/2010	 (DUP)	**FC-6** 12/9/2010	**FC-7** 12/9/2010
VOCs (µg/m^3)										
Vinyl Chloride	0.28	8.5	0.044 U	0.042 U	0.041 U	0.043 U	0.042 U	0.043 U	0.042 U	0.041
1,1-Dichloroethene	91	N/A	0.068 U	0.065 U	0.064 U	0.067 U	0.065 U	0.067 U	0.065 U	0.065 U
cis-1,2-Dichloroethene	16	N/A	0.14 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U
Trichloroethene	0.1	3	0.18 U	**0.24**	**0.19**	**0.20**	**0.18**	**0.20**	**0.20**	0.18 U
Tetrachloroethene	0.42	12.6	**0.89**	**0.55**	**8.4**	**7.8**	**7.9**	**8.1**	**8.4**	0.22 U
trans-1,2-Dichloroethene	32	N/A	0.68 U	0.65 U	0.64 U	0.67 U	0.65 U	0.67 U	0.65 U	0.65 U

Numbers in **bold** font indicate the result meets or exceeds the MTCA cleanup level.

MTCA Cleanup Regulation, chapter 173-340 WAC; MTCA Method B from Ecology website downloaded January 2011 (https://fortress.wa.gov/ecy/clarc/Reporting/CLARCReporting.aspx).

µg/m^3 –micrograms per cubic meter

(DUP) - Field duplicate

MTCA – Model Toxics Control Act

N/A - Not Applicable

U - Compound was analyzed for but not detected above the reporting limit shown

VOCs - Volatile organic compounds

Table 4-6
Summary of Volatile Organic Compounds in Indoor Air
UW Tacoma, University Bookstore

Sample ID: Sample Date: Field QC:	**MTCA Air Cleanup Levels Method B**	**Indoor Air Action Levels**	**UB-1** 5/1/2011	**UB-2** 5/1/2011	**UB-3** 5/1/2011	**UB-4** 5/1/2011	**UB-5** 5/1/2011	**UB-6** 5/1/2011
VOCs ($\mu g/m^3$)								
Vinyl Chloride	0.28	8.5	0.042 U	0.041 U	0.043 U	0.042 U	0.040 U	0.070 U
1,1-Dichloroethene	91	N/A	0.065 U	0.064 U	0.067 U	0.065 U	0.061 U	0.11 U
cis-1,2-Dichloroethene	16	N/A	0.59	0.13 U	0.13 U	0.13 U	0.12 U	0.22 U
Trichloroethene	0.1	3	**1.4**	0.17 U	0.18 U	0.18 U	0.17 U	0.29 U
Tetrachloroethene	0.42	12.6	0.22 U	0.22 U	0.23 U	0.22 U	0.21 U	0.37 U
trans-1,2-Dichloroethene	32	N/A	0.65 U	0.64 U	0.67 U	0.65 U	0.61 U	1.1 U

Numbers in **bold** font indicate the result meets or exceeds the MTCA cleanup level.

MTCA Cleanup Regulation, chapter 173-340 WAC; MTCA Method B from Ecology website downloaded January 2011 (https://fortress.wa.gov/ecy/clarc/Reporting/CLARCReporting.aspx).

$\mu g/m^3$ –micrograms per cubic meter

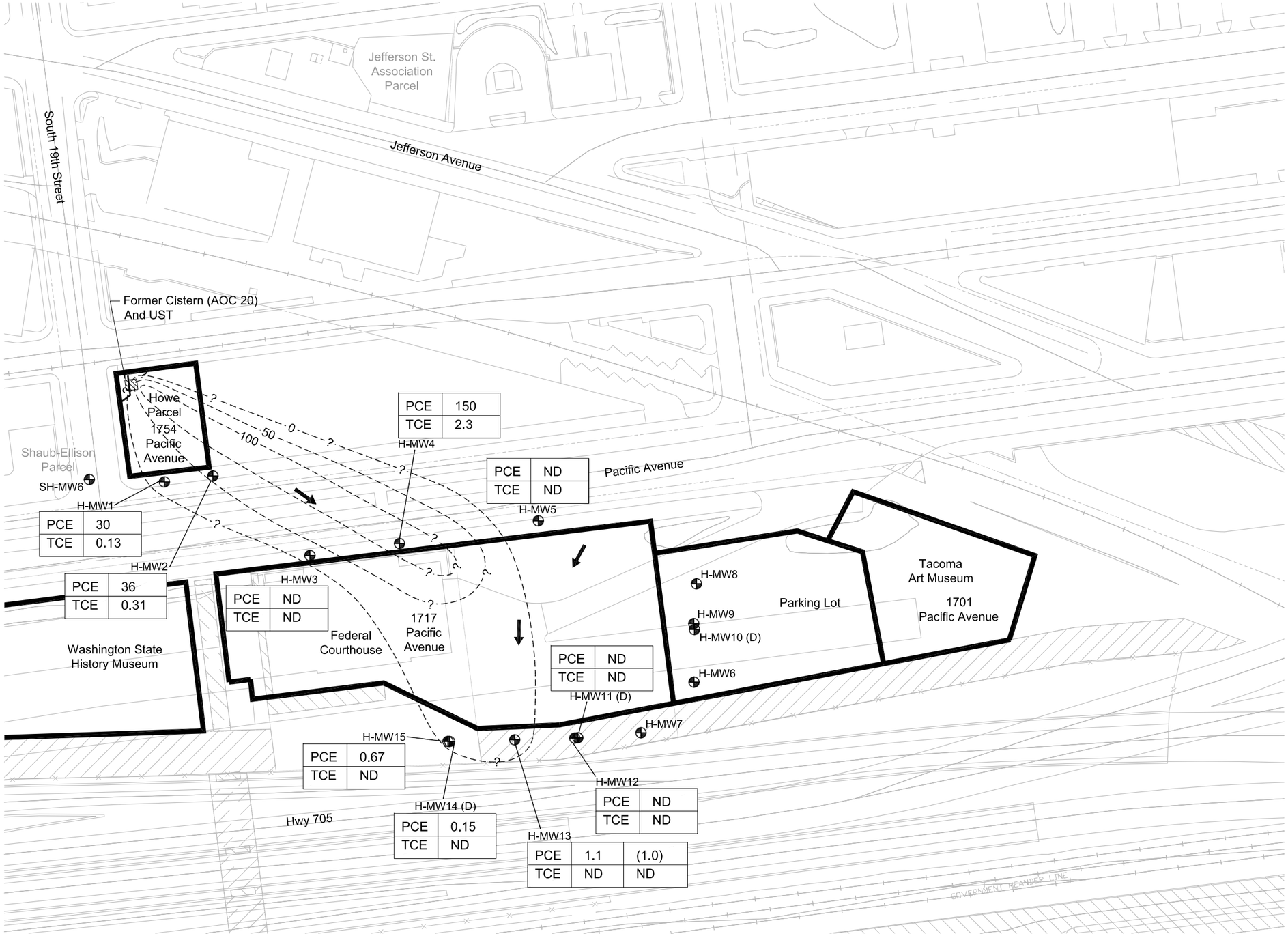
(DUP) - Field duplicate

MTCA – Model Toxics Control Act

N/A - Not Applicable

U - Compound was analyzed for but not detected above the reporting limit shown

VOCs - Volatile organic compounds



Job No. 33762555

URS P:\ACAD\PROJECT\UW-Tac\Campus\Work Plan\Interim Action\Figure 4-1 PCE GW.dwg
Mod: 07/06/2012, 15:23 | Plotted: 07/06/2012, 15:24 | john_knobbs

Figure 4-1

PCE and TCE Concentrations in Groundwater

University of Washington Tacoma Campus
Howe Parcel
INTERIM ACTION WORKPLAN

Figure 4-2
Tetrachloroethene (PCE) in Groundwater for H-MW1 and H-MW3
UW Tacoma, Former Howe Parcel

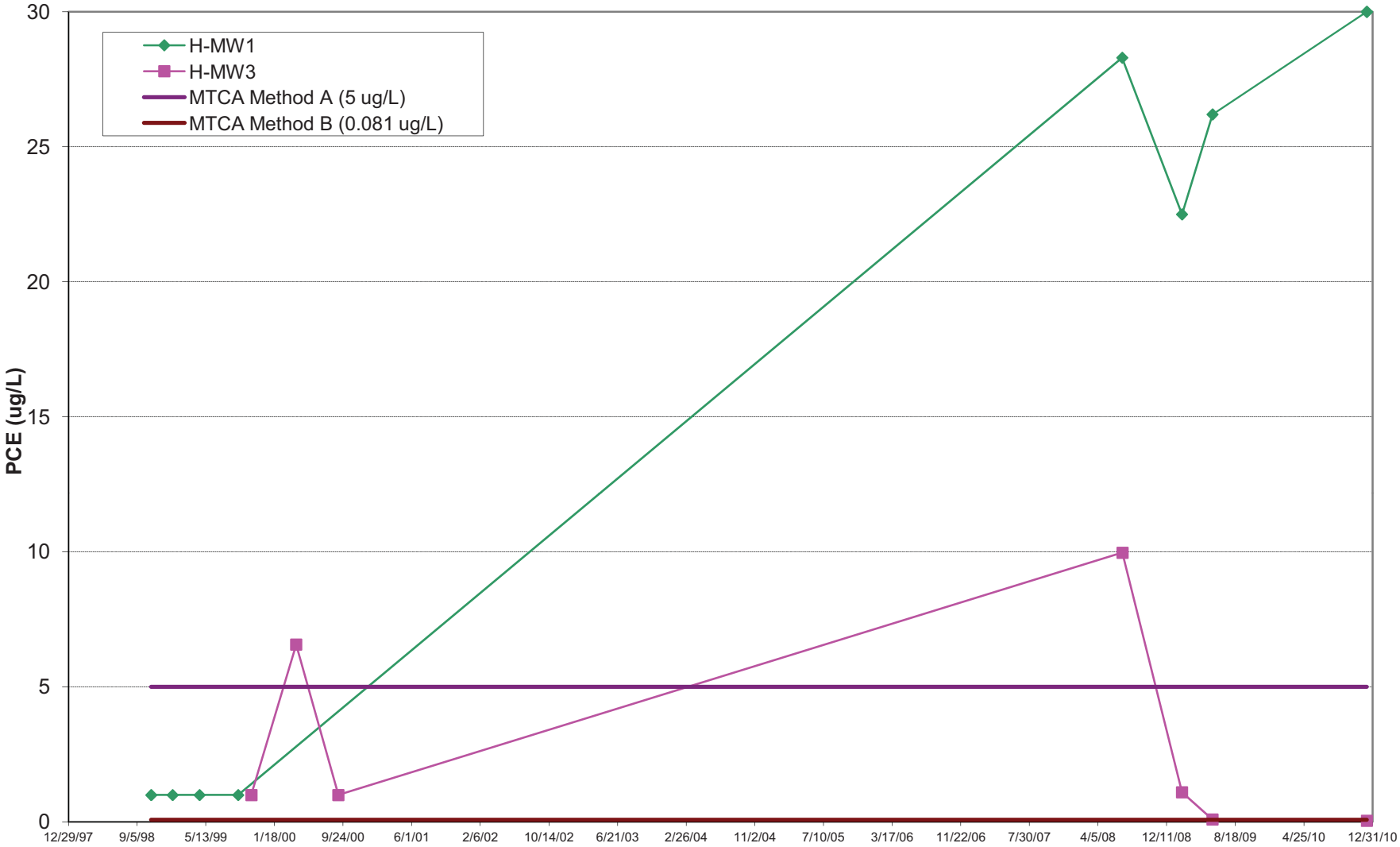
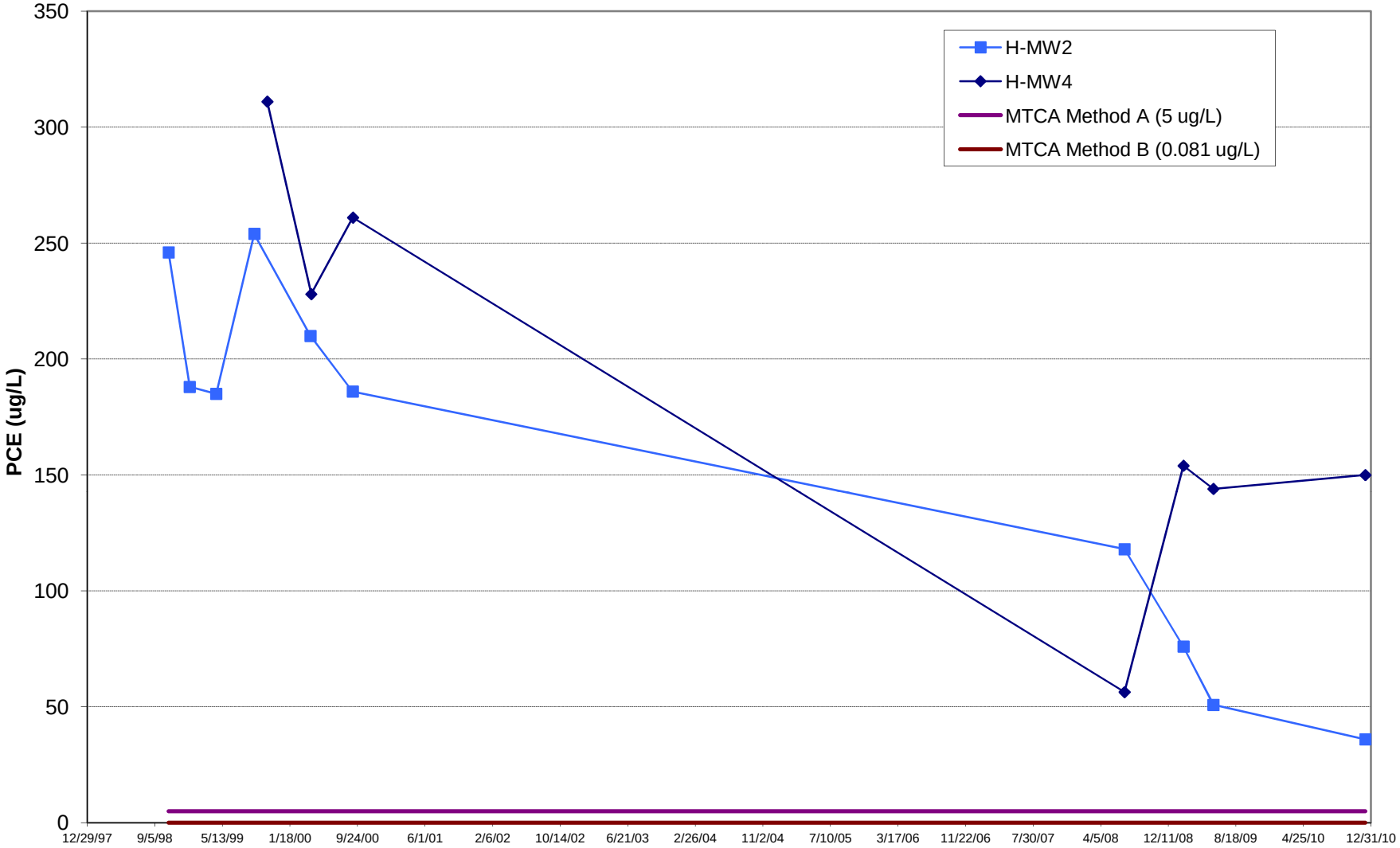


Figure 4-3
Tetrachloroethene (PCE) in Groundwater for H-MW2 and H-MW4
UW Tacoma, Former Howe Parcel



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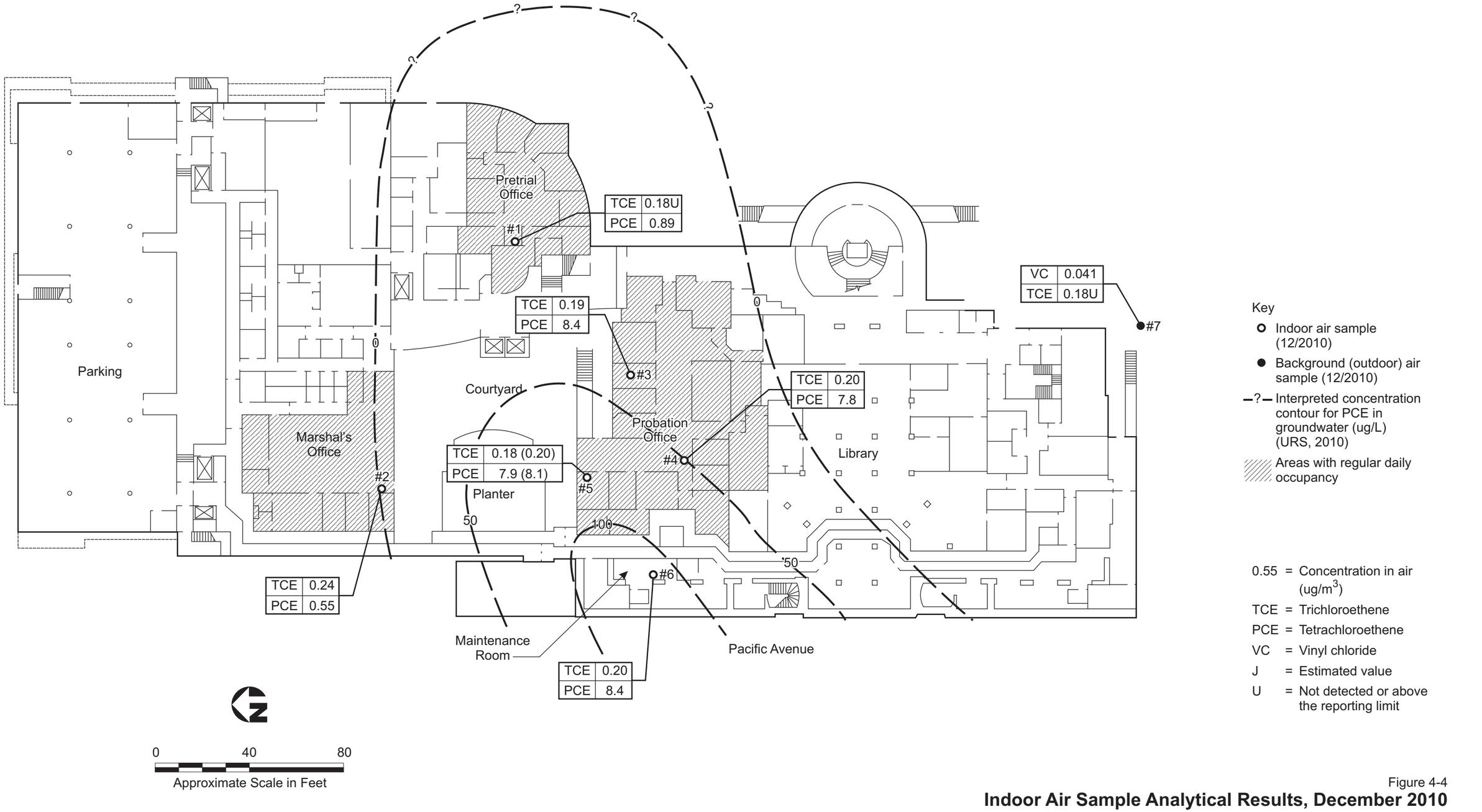


Key

- Indoor air sample (12/2010)
- Background (outdoor) air sample (12/2010)
- —?— Interpreted concentration contour for PCE in groundwater (ug/L) (URS, 2010)
- Areas with regular daily occupancy

0.55 = Concentration in air (ug/m^3)
TCE = Trichloroethene
PCE = Tetrachloroethene
VC = Vinyl chloride
J = Estimated value
U = Not detected or above the reporting limit

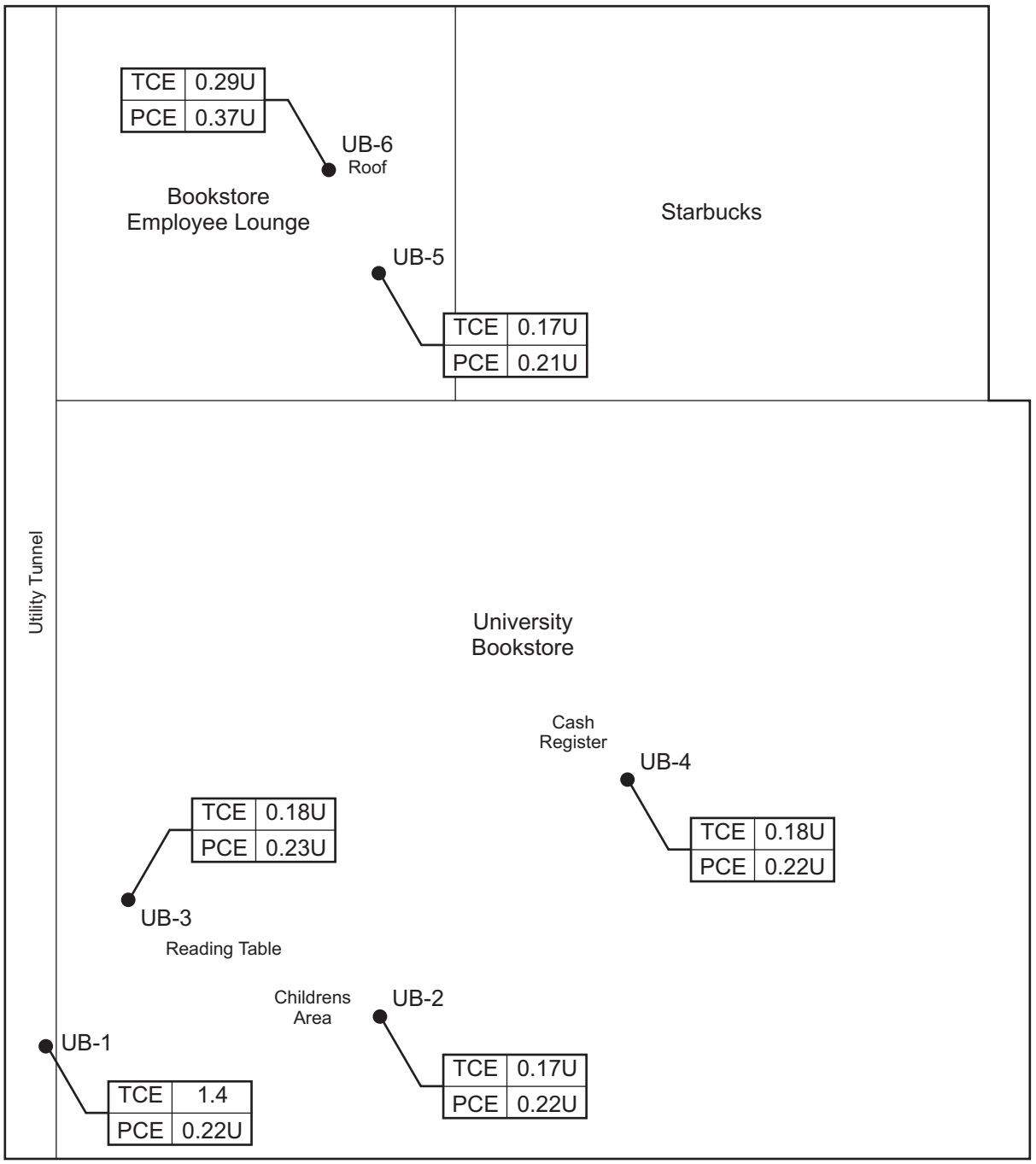
Figure 4-4
Indoor Air Sample Analytical Results, December 2010
Federal Courthouse, Ground Floor

Job No. 33762555

URS

University of Washington, Tacoma Campus
Howe Parcel
INTERIM ACTION WORKPLAN

33762555_26.cdr



Key

- Indoor air sample (5/1/2011)
- Background (outdoor) air sample (5/1/2011)

0.55 = Concentration in air (ug/m^3)
TCE = Trichloroethene
PCE = Tetrachloroethene
VC = Vinyl chloride
U = Not detected or above the reporting limit

N

0 20 40

Approximate Scale in Feet

Figure 4-5

Indoor Air Sample Results, May 2011
UW Bookstore, Ground Floor

Job No. 33762555

URS

University of Washington, Tacoma Campus
Howe Parcel
INTERIM ACTION WORKPLAN

5.0 SUMMARY OF INTERIM ACTION SELECTION PROCESS

As part of the interim action remedy selection process, a draft IAAA was performed by URS in consultation with UW and Ecology (URS 2011d). The purpose of this study was to evaluate potential interim groundwater remedial actions for the Howe PCE plume and to select a preferred alternative that could most appropriately achieve the IA cleanup levels given hydrogeological and other site-specific factors, including but not limited to site logistical considerations such as the presence of nearby active buildings and roadways. The draft IAAA considered the following potential interim groundwater remedial actions for the Howe PCE plume:

- Alternative A-1: Monitored Natural Attenuation
- Alternative A-2: Groundwater Pump and Treat
- Alternative A-3: High Vacuum Extraction
- Alternative A-4: Groundwater Circulation Wells
- Alternative A-5: Permeable Reactive Barrier Using Zero Valent Iron
- Alternative A-6: Enhanced Reductive Dechlorination
- Alternative A-7: Combination of Zero Valent Iron and Enhanced Reductive Dechlorination

The selected interim groundwater remedial action was Alternative A-7: Combination of Zero Valent Iron and Enhanced Reductive Dechlorination. This alternative was ranked the highest in its technical ability to meet the interim action groundwater cleanup levels and other requirements of an interim action as set forth in WAC 173-340-430. Additionally, this IA can be implemented in a manner that does not require permanent remediation infrastructure (other than existing and several future groundwater monitoring wells) and will minimize disruption to the public and nearby businesses.

A detailed evaluation of the above-listed remedial alternatives and the process used to select the preferred interim action remedial alternative may be found in the Draft Interim Action Alternatives Analysis Report dated June 2011 (URS 2011d).

6.0 INTERIM ACTION REMEDY

This section describes the IA groundwater remedy and presents information regarding the remedial system design. The design is based on the injection of a slurry mixture of EHC®, which is unique in that it combines ZVI and organic substrates into a single product (i.e., requires one injection for both products). Other products of ZVI and organic substrates may be appropriate, but they would likely require two separate injections. This may increase costs and require longer times to inject the materials through multiple events. If an alternative product or products is selected in lieu of the EHC®, then the design parameters will be re-evaluated to ensure that they are appropriate for the different treatment material(s). It is not anticipated that a change in supplier for a similar technology (zero valent iron and organic substrate) would result in a change to the groundwater monitoring program discussed in this IAWP. In the event that modifications to the design parameters and/or groundwater monitoring program are warranted based on the selection of a different supplier, then UW will notify Ecology and seek written concurrence by Ecology to implement these changes.

6.1 SUMMARY OF GROUNDWATER INTERIM ACTION

The IA is a combination of ZVI and ERD. This alternative is also referred to as *in situ* chemical reduction. It combines ZVI and ERD technologies to promote more rapid destruction of PCE (and other chlorinated alkenes) through direct contact with ZVI and longer-term treatment of groundwater and saturated soils within the injection and downgradient areas by ERD. The combined carbon and ZVI source is intended to yield strong reducing conditions that will facilitate the destruction of the contaminants of concern, while minimizing the formation of potentially problematic intermediates, such as DCE and VC, from the anaerobic degradation of PCE/TCE.

Implementation of this IA will include the installation of five new groundwater performance monitoring wells along Pacific Ave. and the injection of the ZVI and ERD (organic substrate) in approximately fifty locations (Figure 6-1). The target injection depth interval will extend at least two feet above the groundwater table and approximately 10 feet below the groundwater table. This interval corresponds to the estimated vertical extent of PCE and associated COPCs in groundwater (see Section 4.2). The monitoring wells will be installed with 15 feet of screen consistent with the existing monitoring wells along Pacific Ave., approximately 5 feet of screen above and 10 feet below the groundwater surface. In addition, three groundwater monitoring probes or wells will be installed in the Federal Courthouse courtyard, which has significant access constraints (Figure 6-2).

Prior to injection of the ZVI and ERD, baseline groundwater samples will be collected from selected existing (all except H-MW5 through H-MW10) and all new monitoring wells (and groundwater monitoring probes if used in the courtyard; Figure 6-2) prior to the injection event and will be tested for VOCs by Method 8260B and other groundwater parameters identified in Section 6.4 below. Groundwater samples will not be collected from the direct push injection borings. Groundwater levels will be measured in H-MW5 through H-MW10 to substantiate there has not been a significant change to the groundwater flow direction. The injection of ZVI and organic substrate materials may result in temporary changes to localized flow patterns (i.e., groundwater mounding) in the radius of influence of individual injection points, but no significant long-term changes to groundwater flow direction are anticipated due to the injections. A Sampling and Analysis Plan (SAP), including the methods of installation, depth and type of groundwater monitoring probes/wells in the courtyard, Quality Assurance Project Plan (QAPP)

and Health and Safety Plan (HSP) will be submitted for Ecology review and approval subsequent to approval of this IAWP and prior to installation of the additional monitoring wells/probes and baseline sampling and analysis.

Due to logistical and access constraints, the injection boreholes will be located in the sidewalk areas on both sides of Pacific Ave. During the RI, eight direct-push borings were completed within the uppermost groundwater at depths of up to 43 feet bgs. These borings were located along the east and west sides of Pacific Ave. in the area of the planned injection boreholes. Additional injections may be performed outside on the southwest corner of the University Bookstore building, upgradient of and as close as practicable to the former cistern and associated piping on the former Howe Parcel. Two direct push borings were completed within groundwater to depths of 25 and 27 feet bgs near the southwest corner of the University Bookstore during the RI. More powerful hydraulic-probe rigs are available now than in 1998-2001 when the RI borings were completed. Therefore, there is a very high probability that the injection borings can be completed using a hydraulic probe rig to a depth of at least 10 feet below the top of groundwater in the planned injection locations.

The injection borings will require coring a small hole (several inches in diameter) in the sidewalk or pavement areas at each injection point. The sidewalk/pavement will be patched at the completion of the injection to match existing conditions to the extent practicable. No permanent structures will be left in place following the injections, except for the long-term groundwater monitoring wells, most of which already exist.

6.2 INTERIM ACTION DESIGN

The remedial design discussed below is based on the direct push injections of a combination of controlled-release carbon and ZVI particles called EHC®, which is manufactured by Adventus Group. If the contractor/consultant team selected by UW proposes to use a different supplier of similar materials, then the design details presented below will be confirmed with the selected vendor during the procurement phase. The injection methods, locations, and other design parameters are not expected to vary significantly from those discussed below.

6.2.1 Application Method

EHC® is available as a solid or liquid material that can be placed into the subsurface environment in a variety of ways, including direct mixing, hydraulic fracturing, pneumatic fracturing, direct placement in trenches or excavations, and injection of slurries or liquids using permanent wells or temporary injection borings. For this Howe PCE plume, EHC injection will be accomplished by temporary direct-push injections using hydraulic direct-push equipment. Other drilling methods may be needed (e.g., hollow stem auger or resonant sonic) if the target injection depths cannot be achieved due to the soil conditions (e.g., dense gravelly soils), other drilling methods may be needed (e.g., hollow stem auger or resonant sonic). The direct-push application method was selected for this IA because it is more effective at targeting zones compared to longer-screened injection wells and does not require long-term injection well infrastructure that could create trip/slip/fall hazards to the public within the Pacific Ave. right-of-way. Trenches or excavations are not considered practicable due to logistical constraints (nearby buildings and roadways), and pneumatic or hydraulic fracturing is considered risky due to utilities within the right-of-way that could be damaged by high-pressure fracturing.
The preferred approach for the injections is in the top-down direction, using an injection tip that directs the slurry horizontally (i.e., Geoprobe pressure-activated tip or similar). For each injection point, the rods are initially advanced to the top of the targeted depth interval and a

specified volume of slurry is injected before proceeding down to the next depth. The injections are to be evenly distributed over the targeted depth interval using a vertical injection spacing of approximately 2 to 4 feet. A small amount of water (about 15 US gallons) may be injected to clear the injection tip between batches and at the end of injection. The targeted injection interval will be between 5 to 10 feet within the saturated zone (see Figures 2-2 through 2-5, which show the target treatment zones).

The injection pump should be capable of generating at least 500 pounds per square inch (psi) of pressure at a flow rate of 5 gallons per minute. The pump needs to be able to handle solids. For example, piston pumps, grout pumps, and progressive cavity pumps have worked in the past, with a preference towards piston and grout pumps. EHC® is typically injected at pressures of 100 to 200 psi. However, higher pressures are sometimes required to initiate the injection. Sufficient rod length and injection tips should be available to allow three to five injection points to be capped overnight to prevent backflow if need be.

The EHC injection equipment (product, mixing tanks, injection pump, etc.) should be self-contained to the extent practical to minimize its footprint and facilitate more rapid mobilization and demobilization.

6.2.2 Injection Locations

The number of injection points and their locations are summarized in Table 6-1 and shown on Figure 6-1. The EHC® (or approved equal) will be injected in three areas to create three treatment zones, one directly upgradient of the source area and two perpendicular across the width of the plume. Groundwater flowing through the treatment zones will be treated abiotically with the ZVI and by the fibrous organic carbon, which will promote reductive dechlorination. A portion of the organic carbon will dissolve and migrate downgradient of each zone, thereby promoting reductive dechlorination beyond the initial injection area.

The first zone is upgradient of the PCE plume at the southwest corner of the University Bookstore. While the groundwater upgradient of this treatment zone is expected to be below applicable cleanup levels for the COPCs, the combination of ZVI and organic substrates is expected to create more favorable conditions for reductive dechlorination of residual PCE in the saturated zone in the source area.

The second treatment zone is a line along the sidewalk adjacent to/downgradient of the University Bookstore on the west (upgradient) side of Pacific Ave. The third treatment zone is a line of temporary injection points located on the sidewalk east (downgradient) of Pacific Ave. adjacent to the courthouse. The injection points will be installed at approximately 10-foot intervals, assuming an injection radius of influence (ROI) of 5 feet per injection point. The 5 foot ROI is intended to be a conservative estimate of the ROI based on experience at other sites with similar soil types. This assumption will be evaluated in the field during the initial injections by monitoring nearby groundwater monitoring wells during the injections or by installing temporary direct push monitoring points. The detection of elevated levels of total organic carbon (TOC) and or iron levels in groundwater in observation points will constitute evidence of a positive influence of EHC®. The injection points may be modified in consultation with Ecology based on field conditions. If an alternative product(s) is injected then appropriate monitoring parameters will be established in consultation with and approved by Ecology.

6.2.3 EHC® Mass Requirements and Injection Details

The EHC® will be applied at an average loading rate of 0.5% to soil mass, which results in a total of 47,300 pounds of EHC® required. The actual amount of EHC® will be adjusted based on the actual length of the injection lines as determined from the baseline groundwater monitoring event using the expanded groundwater monitoring well network. Figure 6-1 shows the locations of the new monitoring wells and the injections locations. Table 6-2 summarizes the EHC® mass requirements and injection details.

The EHC® will be delivered as a dry powder in 50-pound bags or 2,000-pound Supersacks. The EHC® slurry will be prepared in a mixing tank with a paddle mixer at the bottom. The slurry can then be transferred to a feed tank connected to the injection way. In this way, the slurry can be prepared continuously while the injections are performed. The ChemGrout mixing system with two mixing bins (www.chemgrout.com/500hp.htm) is an example of a mixing system that has been used for similar applications at other sites.

6.3 GROUNDWATER MONITORING

Groundwater monitoring will be conducted several weeks prior to performing the injections to establish baseline conditions in accordance with the compliance monitoring plan (Appendix A). Groundwater from selected existing and all new groundwater monitoring wells will be sampled and analyzed for the following constituents:

- Field parameters: water level, pH, dissolved oxygen, oxygen reduction potential, and temperature
- Chlorinated VOCs (PCE, TCE, cis 1,2-DCE, trans 1,2-DCE, 1,1-DCE, and VC)
- Dissolved gases (ethane, ethene, and methane)
- Total and dissolved iron and manganese
- Select anions (chloride, sulfate, and nitrate)
- Total organic carbon

Groundwater performance monitoring will be performed on a quarterly basis following the injections over a 12-month period, with the first sampling event scheduled about one to two months after the injection even is complete. Groundwater will be sampled for the same constituents tested in the baseline sampling event. After one year of quarterly post-injection groundwater monitoring, UW and Ecology will evaluate the results and determine whether additional injections and groundwater monitoring is appropriate. Additional injections may be performed if groundwater monitoring data suggest that the injections have been effective at reducing groundwater contaminant levels.

If groundwater monitoring data indicate that the Howe PCE plume is not moving beyond the courthouse property above groundwater action levels (Section 3.5 and Table 3-1), monitored natural attenuation may be used to document long-term protectiveness of the IA. At a minimum, MNA monitoring will include evaluation of groundwater COPC concentration trends over time, PCE breakdown products, groundwater redox parameters (dissolved oxygen, oxidation reduction potential) and pH. Additional information regarding MNA sampling locations and monitoring frequency will be submitted to Ecology for review when that stage of the IA is reached.

The above-listed monitored constituents are based on the use of EHC®. It is not anticipated that a change in supplier for a similar product (zero valent iron and organic substrate) would result in a change to the groundwater monitoring program discussed in this IAWP. In the event that modifications to the design parameters and/or groundwater monitoring program are warranted based on the selection of a different supplier, then UW will notify Ecology and seek written concurrence by Ecology to implement these changes.

6.4 INTERIM ACTION COMPLETION REPORT

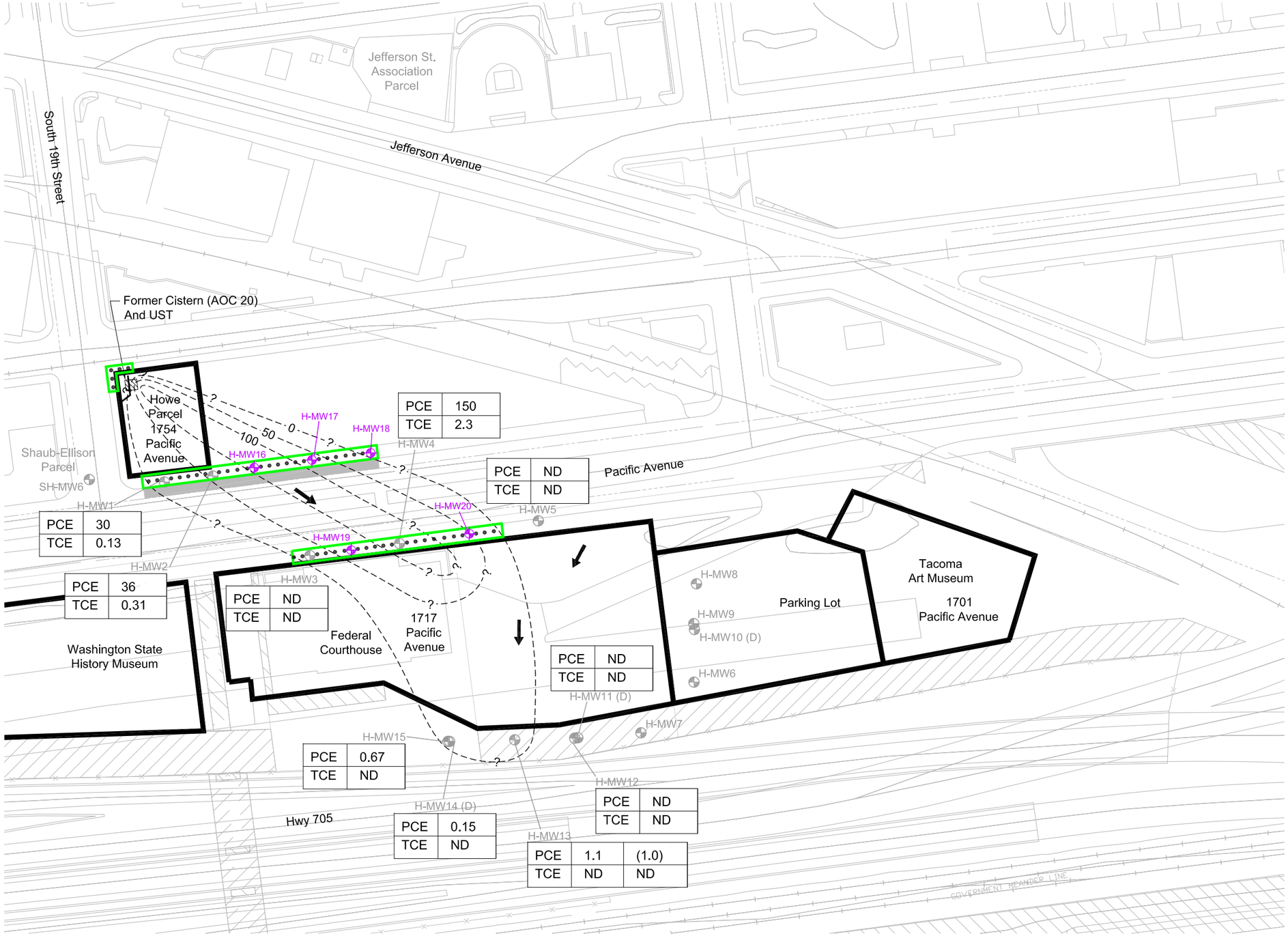
After completing the IA, UW will prepare a draft IA Completion Report for Ecology's review. The purpose of the report is to transmit "As-Built" documents and document that the IA remedial action was performed in accordance with the IAWP and other relevant documents. The report will include, but not be limited to, the following:

- A summary of IA cleanup activities
- A discussion and justification of any deviations from this IAWP
- A discussion of quality assurance/quality control (QA/QC) review and verification process including implications for project data as described in the QAPP
- A figure showing final injection locations
- A figure showing groundwater performance and compliance monitoring sampling locations
- A summary table of available performance monitoring results
- Copies of daily reports, field notes (including field screening logs and sample data sheets) and photographs
- Copies of waste disposal documentation, including manifests, weight slips and receipts
- Copies of laboratory analytical results and chains-of-custody

Table 6-1
Approximate Number of Injection Points

ID No.	Location	Length (feet)	No. Injection Points
1	Southwest corner of bookstore	70	5
2	Sidewalk adjacent to bookstore	280	23
3	Sidewalk adjacent to courthouse	240	21
Total	**--**	**580**	**49**

Note: See Figure 6-1 for locations



Legend

- H-MW43 — Monitoring Well
- Proposed Monitoring Well
- Proposed Injection Boring/Well (Typ. 10 foot spacings)
- Former AOC or SWMU
- Proposed ERD and ZVI Injection Alignment
- Parking Area

Interpreted Contours of Equal Constituent Concentrations in Groundwater

- PCE Concentration ug/L
- ? Extent Uncertain
- Inferred Groundwater Flow Direction
- 1.71 — Concentration in Micrograms Per Liter (ug/L)
- ( ) — Duplicate Sample Result
- (ND) — Not Detected
- (D) — Deep (25') Well Adjacent to Shallow (15') Well
- PCE — Tetrachloroethene
- TCE — Trichloroethene

Note:
Groundwater sampled 2010

0 60 120
SCALE IN FEET

Job No. 33762555

URS P:\ACAD\PROJECT\UW-Tac\Campus\Work Plan\Interim Action\Figure 6-1 Insitu.dwg
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Figure 6-1
Injection Point and Monitoring Well Locations
University of Washington Tacoma Campus
Howe Parcel
INTERIM ACTION WORKPLAN

33762555_27.cdr

Key

- Groundwater monitoring location
- –?– Interpreted concentration contour for PCE in groundwater (ug/L) (URS, 2010)
- Areas with regular daily occupancy

0 40 80

Approximate Scale in Feet

Figure 6-2

Proposed Groundwater Monitoring Locations
Federal Courthouse, Ground Floor

Job No. 33762555

URS

University of Washington, Tacoma Campus
Tacoma, Washington

Table 6-2
EHC® Mass Requirements and Injection Details

ID No.	Description	Value	Units
PRB dimensions			
1	Total PRB Length	580	feet
2	PRB Width	10	feet
3	PRB Thickness	10	feet
4	PRB Volume	58,000	cubic feet
5	Mass of Soil in PRB	3,200	US tons
6	Estimated porosity	30	percent
7	Volume pore space	17,400	cubic feet
EHC® mass calculations			
8	Percentage EHC® by soil mass	0.50	percent
9	Linear groundwater velocity	0.1	feet per day
10	Contact Time	20	days
11	Contact time * application rate multiplier	10	days*% EHC®
12	Mass of EHC® required	32,000	pounds
Preparation of EHC® slurry			
13	Percent solids in slurry	29	percent
14	Volume of water required	9,400	US gallons
15	Slurry volume	11,500	US gallons
PRB Injection Layout			
16	Number of injection lines	3	lines
17	Spacing between injection points	10	feet
18	Number of injection points in Line 1	5	points
19	Number of injection points in Line 2	23	points
20	Number of injection points in Line 3	21	points
21	Total number of injection points	49	points
Injection details			
22	Mass of EHC® per point	653	pounds
23	Water volume per point	192	US gallons
24	Slurry volume per point	235	US gallons
25	Number of layers per point	3	layers/point
26	Mass EHC® per layer	212	pounds
27	Water volume per layer	64	US gallons
28	Slurry volume per layer	78	US gallons
Application rates for reference			
29	Slurry volume to pore space volume	8.8	percent
30	EHC® concentration in groundwater	1.84	pounds per cubic foot

Notes:

[1] Input values for this table is based on information provided by Adventus in correspondence dated September 29, 2009.

[2] See Figure 6.1 for approximate locations of injection points. The number and location of injection points are approximate and may vary somewhat from those depicted on Figure 6-1 based on field conditions.

[3] Linear groundwater velocity values were based on the calculated value reported in Interim Action Alternatives Analysis Report (URS 2011d).

7.0 SCHEDULE

Table 7-1 presents a milestone schedule for implementing the Interim Action Work Plan.

Table 7-1
Milestone Schedule

Milestone Description	Completion Date*
UW Plans and Specifications and Contract Selection	120 days after the effective date of the AO Amendment
SAP, QAPP, HSP and Permits	90 days after Notice to Proceed is issued by UW to the Contractor and acceptance of the SAP, QAPP, and HSP by Ecology
Groundwater Monitoring Well Installations and Baseline Groundwater Sampling and Analysis	60 days following receipt of permits from City of Tacoma
Cleanup Reagent Injections	60 days following completion of baseline groundwater monitoring
Initiate Performance Monitoring	60 days following completion of reagent injections
End 1-Year of Performance Monitoring	Minimum 1 year duration and termination contingent on Ecology approval
Interim Action Completion Report	Within 30 days of completion of the last groundwater performance monitoring event for the groundwater IA and Ecology written notification that the IA is complete
Begin Confirmational Monitoring	60 days following meeting IA cleanup goals in all groundwater monitoring wells or 60 days following notification by Ecology that no further active IA remedial actions are required for the Howe PCE plume
End Confirmational Monitoring	1-year after initiating groundwater compliance monitoring if IA cleanup levels are achieved or as determined by Ecology if IA cleanup levels are not achieved

*An extension to the listed due dates may be granted by Ecology under the terms of the Agreed Order, Section VIII.K, (Extension of Schedule).

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APPENDIX A
INTERIM ACTION COMPLIANCE MONITORING PLAN

TABLES

FIGURES

1.0 INTRODUCTION

The purpose of this Compliance Monitoring Plan (CMP) is to provide procedures to be followed to assess and document that the interim action (IA) groundwater IA cleanup levels have been achieved for the groundwater plume of tetrachloroethene (PCE) and related volatile organic compounds (VOCs) from the former Howe Parcel (Howe PCE plume) on the University of Washington (UW) campus in Tacoma, Washington. This CMP was prepared to supplement the IA Work Plan and is consistent with the requirements of the Agreed Order between the UW) and the Washington State Department of Ecology (Ecology). This CMP was also prepared in accordance with the Model Toxics Control Act (MTCA) regulation (WAC 173-340-410, -720, and -820). Groundwater monitoring will be performed in accordance with a project-specific Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP), which will be prepared by the consultant selected by UW to design and implement the IA and CMP. These supplemental plans to this CMP will be prepared consistent with Ecology's applicable guidance documents (Ecology 1994, 2004) and submitted for Ecology approval prior to implementation of the CMP.

1.1 Overview of Site Hydrogeology

In the Howe PCE groundwater plume area, the uppermost contiguous groundwater typically occurs within glacial deposits at depths ranging from approximately 13 feet to 31 feet below ground surface (bgs), except east of Pacific Avenue beneath and adjacent to the Federal Courthouse, where groundwater occurs at depths ranging from 1 to 7 feet bgs. Typical seasonal variations of 1 to 5 feet have been measured in individual monitoring wells. The shallow groundwater is unconfined and groundwater flow beneath the site is to the east-northeast. There are no known drinking water wells in the uppermost groundwater (perched or within the upper glacial deposits) located within one mile of the site. There are a number of resource protection wells (monitoring wells) in this one-mile area.

The conclusions associated with groundwater occurrence and flow presented in the draft Remedial Investigation (RI), a subsequent technical memo, and draft Interim Action Alternatives Analysis (IAAA) (URS 2002, 2011a, 2011b) are as follows:

- Uppermost groundwater is unconfined and typically occurs at a depth of approximately 13 to 23 feet bgs along the west side of Pacific Avenue (wells H-MW1 and H-MW2), 28 to 31 feet bgs along the east side of Pacific Avenue (wells HMW-3, H-MW4 and H-MW5), and 1 to 7 feet bgs on the Federal Courthouse and adjacent parking lot property (wells H-MW6 through H-MW15).

- The groundwater flow direction across the UW Tacoma Campus and within the Howe plume is northeasterly to easterly toward the Thea Foss Waterway, which is consistent with previous interpretations of the regional groundwater flow in the site vicinity. There is no significant seasonal change in flow direction.

- The horizontal gradient within the Howe plume is 0.035 foot per foot between wells H-MW2 and H-MW4, but decreases to 0.025 foot per foot between wells H-MW4 and H-MW14/15.

- Groundwater elevations for paired monitoring wells BL-MW1/BL-MW5 and BL-MW3/BL-MW6 in the south-central portion of the UW Tacoma Campus indicate there is a downward vertical gradient in the uppermost groundwater, whereas paired wells east of Pacific Avenue (H-MW9/H-MW10 and H-MW14/H-MW15) indicate there is an upward vertical gradient in the uppermost groundwater.

1.2 Summary of Groundwater Interim Actions

The selected groundwater interim remedial action for the Howe PCE plume is in-situ chemical reduction using a combination of zero valent iron (ZVI) and organic substrates, followed by natural attenuation. The preferred injection material is EHC™ by Adventus Group. The EHC™ relies on a combination of chemical and biological treatment mechanisms, including direct abiotic reduction, indirect chemical reduction via reduced metals, and biostimulation as EHC™ fermentation produces volatile fatty acids (VFAs) and hydrogen to stimulate dehalogenators downgradient of the injection locations.

Groundwater performance monitoring will be conducted on a quarterly basis to document the effectiveness of the remedy over time for a minimum of 12 months. The initial groundwater monitoring event will be initiated approximately 2 months following the injection. Since it is not practicable to treat the entire plume with EHC™ because of logistical constraints (access constraints inside of buildings, the courthouse courtyard, and within Pacific Avenue), natural attenuation will be used to decrease post remediation groundwater concentrations to IA groundwater cleanup levels. The applicable groundwater cleanup levels for the Howe Parcel PCE plume are MTCA Method A levels. Method B levels will be used as a measure for those constituents that do not have established Method A cleanup levels to monitor the progress of the IA such as evaluating the IA for changes in degradation product concentrations and determining action levels that trigger an additional action.).

At a minimum, MNA monitoring will include evaluation of groundwater COPC concentration trends over time, including PCE breakdown products, groundwater redox parameters (dissolved oxygen, oxidation reduction potential) and pH. Additional information regarding MNA sampling locations and monitoring frequency will be submitted to Ecology for review when that stage of the IA is reached.

Contingency IA remedial actions may be undertaken in the event that groundwater monitoring data suggests that the VOC plume may migrate further downgradient of the Federal Courthouse property towards the Thea Foss Water Way at concentrations greater than IA action levels. These potential actions are outlined in the IAWP and may include additional injections or other measures approved by Ecology.

1.3 Groundwater Interim Action Cleanup Levels and Action Levels

1.3.1 Groundwater Interim Action Cleanup Levels

The IA groundwater cleanup levels for the Howe PCE plume are MTCA Method A levels. MTCA Method B levels will be used as a measure for those constituents that do not have established Method A cleanup levels to monitor the progress of the IA, such as in evaluating the IA for degradation products and to determine action levels that trigger an action. The applicable interim action groundwater cleanup levels and action levels for the constituents of concern are summarized in Table A-1.

Table A-1
Summary of Interim Action Groundwater Cleanup Levels and Action Levels

	Groundwater				
Contaminant of Potential Concern	**MTCA Method A Level (µg/L)**	**MTCA Method B Level (µg/L)**	**IA Cleanup Level[b] (µg/L)**	**IA Action Level[c] (µg/L)**	**Concentration Range Detected Above MTCA and IA Cleanup Level[d] (µg/L)**
PCE	5.0	NA	5.0	3.75	6.57–311
TCE[a]	5.0	NA	5.0	3.75	5.49–12
cis-1,2 DCE[a]	NA	16	NA	12	NA
trans-1,2 DCE[a]	NA	160	NA	120	NA
1,1-DCE[a]	NA	400	NA	300	NA
Vinyl Chloride[a]	NA	0.2	NA	0.15	NA

Notes:
a. Potential degradation product from PCE.
b. Applicable IA cleanup level for Howe Parcel PCE Plume is MTCA Method A
c. IA action level is 75-percent of IA cleanup level or 75-percent of MTCA Method B level if there is no established Method A level
d.Concentration range includes data from groundwater samples collected from monitoring wells and borings (grab and probe samples).

µg/L–micrograms per liter
DCE–dichloroethene
MTCA–Model Toxics Control Act
NA-not applicable
PCE – tetrachloroethene
TCE–trichloroethene

1.3.2 Groundwater Action Levels

Groundwater action levels have been established at select sentry wells (H-MW11 through H-MW15) located downgradient of the Federal Courthouse building. The action levels are 75% of the applicable MTCA Interim Action cleanup levels in Table A-1. Specific actions to be undertaken in the event that the groundwater action levels are exceeded are described in the IAWP and Section 8 of this CMP.

1.4 Groundwater Monitoring Objectives and Rationale

As discussed in Section 1.2, the proposed IA remedial actions at the former Howe Parcel site include the injection of ZVI and an organic substrate into the subsurface to promote in situ

chemical reduction of PCE and its breakdown products in groundwater. Groundwater monitoring will be performed before, during, and after the injections to assess the effectiveness of the interim remedial measures. If the groundwater action levels are exceeded during the course of groundwater monitoring, then the UW will implement additional measures, as described in the IAWP and Section 8 of this CMP.

Groundwater will be monitored throughout the cleanup process to assess the effectiveness of the IA remedial action and to ensure long-term protectiveness of the remedy. Contingency measures will be implemented in the event that groundwater monitoring data indicates that the groundwater plume is migrating further downgradient of the Federal Courthouse towards the Thea Foss Waterway.

1.5 Monitoring Types and Locations

1.5.1 Types of Monitoring and Monitored Parameters

Compliance monitoring will consist of groundwater monitoring. Figure A-1 identifies injection point and monitoring well locations (including existing wells and five proposed new wells located on the east and west sides of Pacific Ave.). Figure A-2 identifies three additional proposed groundwater monitoring locations within the courtyard of the Federal Courthouse building. Table A-2 summarizes the parameters that will be monitored and analytical methods to be used during the IA performance monitoring program.

Table A-2
Summary of Groundwater Monitored Parameters

Constituent	Method
Constituents of Concern	
PCE	EPA 8260B
TCE	EPA 8260B
cis 1,2-DCE	EPA 8260B
trans 1,2-DCE	EPA 8260B
1,1 DCE	EPA 8260B
VC	EPA 8260B
Groundwater Field Parameters	
Groundwater Elevation	Field Method
Temperature	Field Method
Dissolved Oxygen	Field Method
pH	Field Method
Oxidation Reduction Potential (ORP	Field Method
Conductivity	Field Method
Redox Indicator Parameters	
ORP	Field Method
Sulfate	SM-4500
Degradation Parameters	
Chloride	EPA 300.0
Methane	RSK 175 M

Ethane	RSK 175M
Ethene	RSK 175 M
EHC Indicator Parameters	
Ferrous Iron (Fe^{2+})	SM 3500
Total Organic Carbon (TOC)	SM 5310

1.5.2 Groundwater Monitoring Locations

The groundwater monitoring network consists of 20 groundwater monitoring wells (H-MW1 through H-MW-20). Groundwater wells H-MW-1 through H-MW-15 are existing wells and H-MW-16 through H-MW-20 are proposed new groundwater monitoring wells. Based on the monitoring results, the number of monitoring wells may be reduced in consultation with Ecology after the first year of post-injection groundwater monitoring. Groundwater samples will not be collected from existing monitoring wells H-MW5 through H-MW10 but groundwater elevation levels will be measured in order to assess potential changes in groundwater flow in the plume area. If future data indicate that groundwater flow becomes more northeasterly towards these wells on a consistent basis, then groundwater samples may be collected from one or more of these wells.

2.0 PROTECTION MONITORING

The objective of protection monitoring is to document that human health and the environment are adequately protected during all phases of the cleanup action (WAC 173-340-410(1)(a). Protection monitoring will be addressed in the health and safety plan that will be prepared by the consultant and contractor that implement the interim groundwater cleanup action and monitoring.

3.0 PERFORMANCE MONITORING

The objective of performance monitoring is to demonstrate that the interim action has attained performance objectives and interim action cleanup levels (WAC 173-340-410(1)(b). Performance monitoring will consist of groundwater monitoring.

3.1 Groundwater Monitored Parameters

The following groundwater parameters will be used to assess the effectiveness of the interim action groundwater remedy and are shown on Table A-3:

3.1.1 Constituents of Concern

The primary measure that will be used to assess the performance of the interim action groundwater remedy is the concentrations of the constituents of concern, as measured by the laboratory (EPA Method 8260B). Groundwater concentrations will be compared to the applicable IA cleanup levels. Groundwater concentrations in the downgradient monitoring wells (HMW-6 through HMW-15) will be compared to the groundwater action levels and additional actions will be undertaken by UW in consultation with Ecology if these groundwater action levels are exceeded (see Section 8).

Table A-3
Summary of Groundwater Monitoring Locations, Monitored Parameters, and Rationale
Howe PCE Plume Interim Cleanup Action

Sample Location	COCs[1]	Field Parameters[2]	Groundwater Elevation	Redox Parameters[3]	Degradation Parameters[4]	EHC Indicator Parameters[5]	Rationale[6]
H-MW1	X	X	X	X	X	X	Performance Monitorng
H-MW2	X	X	X	X	X	X	Performance Monitorng
H-MW3	X	X	X	X	X	X	Performance Monitorng
H-MW4	X	X	X	X	X	X	Performance Monitorng
H-MW5			X				Performance Monitorng
H-MW6			X				Performance Monitorng
H-MW7			X				Performance Monitorng
H-MW8			X				Performance Monitorng
H-MW9			X				Performance Monitorng
H-MW10			X				Performance Monitorng
H-MW11	X	X	X	X	X	X	Action Levels, Performance Monitorng
H-MW12	X	X	X	X	X	X	Action Levels, Performance Monitorng
H-MW13	X	X	X	X	X	X	Action Levels, Performance Monitorng
H-MW14	X	X	X	X	X	X	Action Levels, Performance Monitorng
H-MW15	X	X	X	X	X	X	Action Levels, Performance Monitorng
H-MW16	X	X	X	X	X	X	Performance Monitorng
H-MW17	X	X	X	X	X	X	Performance Monitorng
H-MW18	X	X	X	X	X	X	Performance Monitorng
H-MW19	X	X	X	X	X	X	Performance Monitorng
H-MW20	X	X	X	X	X	X	Performance Monitorng
H-FC-1	X	X	X	X	X	X	Performance Monitorng
H-FC-2	X	X	X	X	X	X	Performance Monitorng
H-FC-3	X	X	X	X	X	X	Performance Monitorng

1. COCs include PCE, TCE, cis 1,2-DCE, trans 1,2-DCE, 1,1-DCE, and vinyl chloride by EPA Method 8260B.
2. Groundwater field parameters include: temperature, pH, conductivitiy, and dissolved oxygen.
3. Redox parameters include: Oxidation reduction potential (ORP) by field instrument and sulfate by SM-4500 or approved equal.
4. Degradation parameters include: ethane, ethene, methane by Method RSK 175M or approved equal and chloride by EPA Method 300.0 or approved equal.
5. EHC indicator parameters include: ferrous iron (Fe^{2+}) by Method SM 3500 or approved equal and total organic carbon (TOC) by Method SM5310 or approved equal.
6. Confirmational monitoring wells and monitored parameters will be determined in consultation with Ecology when it is demonstrated that the IA objectives are met.

3.1.2 Redox indicator Parameters

The oxidation-reduction potential (ORP) of the groundwater will be monitored using field instrumentation during the quarterly groundwater sampling events. The introduction of the ZVI and organic substrates should substantially decrease the ORP levels (i.e., make them more negative). Sustained ORP levels more negative than -100 millivolts indicate reducing conditions favorable for reductive dechlorination. Additionally, sulfate will be monitored in groundwater. A decrease in sulfate levels compared to baseline conditions suggest reducing conditions have been achieved.

3.1.3 Degradation end products.

Groundwater will be tested for the dissolved gases ethane and ethene as part of the quarterly groundwater performance monitoring period. The presence of ethane/ethene in groundwater is an indication of the complete reductive dechlorination of the contaminants of concern.

3.1.4 Groundwater elevations and field parameters

Depth to groundwater, and groundwater field parameters (dissolved oxygen, temperature, pH, ORP, and conductivity) will be measured and recorded prior to collecting groundwater samples to assess general groundwater conditions during the performance monitoring period.

3.1.5 EHC indicator parameters

To assess whether the wells are in fact under the EHC zone of influence, the groundwater wells will be sampled for total organic carbon (TOC) and ferrous iron (Fe[II]) during groundwater performance monitoring events and during the injection events. Concentrations of these constituents should increase if the groundwater is under the influence of the EHC. If an alternative product(s) is injected then appropriate monitoring parameters will be established in consultation with and approved by Ecology.

3.2 Groundwater Monitoring Schedule

Baseline groundwater sampling will be conducted approximately 2 months prior to performing the first injection event. Groundwater performance monitoring will be conducted on a quarterly basis for a 12-month period following the injections beginning about two to three months following the first injections. The UW will evaluate the groundwater data following the performance monitoring period and determine in consultation with Ecology if additional active groundwater treatment or natural attenuation of the residual plume is appropriate.

4.0 CONFIRMATIONAL AND SENTRY MONITORING

The objective of conformational monitoring is to confirm the long-term effectiveness of the IA cleanup action once performance and IA cleanup standards have been met (WAC 173-340-410(1)(c). Confirmational groundwater monitoring will occur on a quarterly basis for the first year after it is demonstrated IA objectives are met. This schedule could be modified after discussion with and approval from Ecology.

5.0 DATA EVALUATION

5.1 Data Validation

All chemistry data will be validated according to United States Environmental Protection Agency (USEPA) data validation guidelines (USEPA 1994a and 1994b). Data evaluation will include evaluation of holding times, method blank results, surrogate recovery results, field and laboratory duplicate results, completeness, detection limits, laboratory control sample results, and chain-of-custody forms. After the data has been validated, it will be entered into the project database with any assigned data qualifiers.

5.2 Data Evaluation

5.2.1 Groundwater Performance Monitoring Data

Groundwater monitoring data will be reviewed to see if the data are providing the information needed to evaluate the effectiveness of the groundwater remedy. If these data are not sufficient for the evaluation, UW may propose to Ecology adding additional parameters.

5.2.2 Groundwater Confirmational and Sentry Monitoring Data

Groundwater chemistry data will be evaluated after it is validated. The data will be compared to the IA cleanup levels and action levels in the sentry wells (H-MW11 through H-MW15). If a COPC concentration from a sentry well sample is greater than the action level (note: concentrations have historically been below the action levels in these wells), Ecology will be notified and the applicable well(s) will be resampled to verify the result. Resampling of the affected well(s) will occur within one month of receiving the laboratory data. If groundwater concentrations remain above the action levels after three consecutive resampling events, then contingency measures will be implemented as described in the IAWP and Section 8 of this CMP.

5.2.4 Annual Site Review

Groundwater data will be evaluated after 12-month following the injections and annually thereafter until it is demonstrated that IA objectives are met. This schedule could be modified after discussion with and approval from Ecology. Spatial and temporal changes in monitored

parameters will be evaluated to determine the effectiveness and rate of contaminant degradation in the Howe PCE plume.

Groundwater contaminant data will be evaluated using time-trend plots and data comparison to IA cleanup levels. Time-trend plots will be prepared for each contaminant of concern detected above the practical quantification limits (PQL) in select wells trends will be identified by visual observation. The time-trend plots will be used to evaluate long-term trends in the compliance wells and to put the comparisons to IA cleanup levels in context. Trend plots for additional wells or plots depicting other trend metrics (e.g., trends in groundwater concentrations with distance from the injection lines) may be prepared on a case-by-case basis upon review of the data or at the request of Ecology. A groundwater elevation contour map will be prepared to verify groundwater flow directions have not changed significantly. Groundwater isoconcentration and elevation contour maps also will be prepared showing the groundwater plume configuration and flow after each of the four quarterly monitoring events following the injections.

After one year of post-injection groundwater monitoring, if groundwater contaminant concentration trends are declining, the sampling frequency, number of locations sampled, and number of parameters may be reduced if approved by Ecology.

6.0 CRITERIA FOR MEETING PERFORMANCE AND COMPLIANCE STANDARDS

6.1 Groundwater Performance Monitoring

Groundwater performance monitoring will continue until the IA groundwater cleanup levels are reached or until such time as groundwater monitoring data suggest that the plume is not presenting an unacceptable risk to human health or the environment and Ecology determines further active remediation is not warranted. Changes to the performance monitoring program may be made if approved by Ecology to optimize the groundwater monitoring program. Potential changes to the performance monitoring plan will be evaluated on a yearly basis as part of an annual site review.

6.2 Confirmational Monitoring

Confirmation monitoring will be implemented after it is demonstrated that the IA objectives are met. The conformational monitoring plan could be modified after discussion with and approval by Ecology. After discussion with and approval from Ecology, the confirmational monitoring program could be modified from the performance monitoring program and could have a more limited set of analyses, fewer monitoring points and less frequent monitoring. The proposed revisions to the confirmational monitoring plan, if any, will be submitted to Ecology for review and comment/approval prior to implementation of the confirmational monitoring program.

The confirmational groundwater monitoring program will be based on a review of the performance monitoring groundwater quality data. The review of the groundwater quality data will be focused on evaluating groundwater quality trends and not a single event or a single exceedance in a single well. Groundwater quality data will be tabulated and trend plots prepared

as part of the annual site monitoring report. If the chemical analytical results are all below the IA groundwater cleanup levels after one year of quarterly conformational monitoring, then the UW will seek approval from Ecology to reduce or eliminate further groundwater conformational monitoring associated with the Howe PCE plume. In the event that Ecology determines that conformational monitoring needs to extend beyond a 1-year period but no further active groundwater remediation is necessary, then UW may submit to Ecology a revised conformational monitoring plan for Ecology's approval. The revised conformational monitoring plan may reduce the groundwater monitoring frequency (i.e., from quarterly to semi-annually or annually), the number of wells, and parameters monitored, if appropriate.

7.0 REPORTING

Monitoring data will be submitted to Ecology throughout the confirmational and performance monitoring program. Ecology will also be notified within 10 days if a groundwater action level is exceeded. Data will be submitted in the following reports:

- **Quarterly Data Reports.** A data report will be submitted to Ecology on a quarterly basis to present the monitoring data collected during the previous quarterly monitoring event. The quarterly reports will include a transmittal letter with the following attachments:

  - Summary table of groundwater data
  - Summary table of groundwater elevation data
  - Summary table of groundwater field parameters
  - Groundwater elevation contour map
  - Updated groundwater VOC isoconcentration contour map
  - Data validation memorandum
  - Copies of analytical reports

- **Annual Reports.** An annual report will be prepared and submitted to Ecology. The report will include:

  - Data tables
  - Groundwater trend-line figures
  - Groundwater elevation and isoconcentration contour maps
  - Recommended changes to groundwater performance or confirmational monitoring program (if any)

8.0 CONTINGENCY PLAN

The following actions will be implemented in the event that groundwater action levels are exceeded in one or more well(s) located downgradient of the Federal Courthouse building.

- Notify Ecology within 10 days of receiving the analytical report that indicates that an action level is exceeded.

- Resample the affected well(s) within 30 days of receiving the analytical report that indicates an action level is exceeded.
- If resampling confirms that one or more COPC concentrations are above applicable action levels, but below applicable IA cleanup levels, then the groundwater monitoring frequency of the affected well(s) will be increased from quarterly to monthly until a trend can be established (i.e., at least three consecutive sampling events). If groundwater COPC concentration trends indicate that IA cleanup levels will not likely be exceeded, then groundwater monitoring frequency may be reduced in consultation with Ecology.
- If resampling confirms that IA action levels are exceeded and IA cleanup levels are likely be exceeded based on increasing trends in COPC concentrations, then submit a plan to Ecology proposing further remedial measures in the area east of the Federal Courthouse within 30 days of receiving the confirming analytical results.
- Implement additional IA remedial measures (i.e., additional injections at Federal Courthouse property or other Ecology-approved measures) within 60 days of receiving Ecology approval.

9.0 REFERENCES

URS. 2002. Draft Remedial Investigation Report (Rev 1.1) University of Washington, Tacoma Campus. November 18.

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Washington State Department of Ecology (Ecology). 1995, Guidance on Sampling and Data Analysis Methods, Publication 94-49, January 1995.

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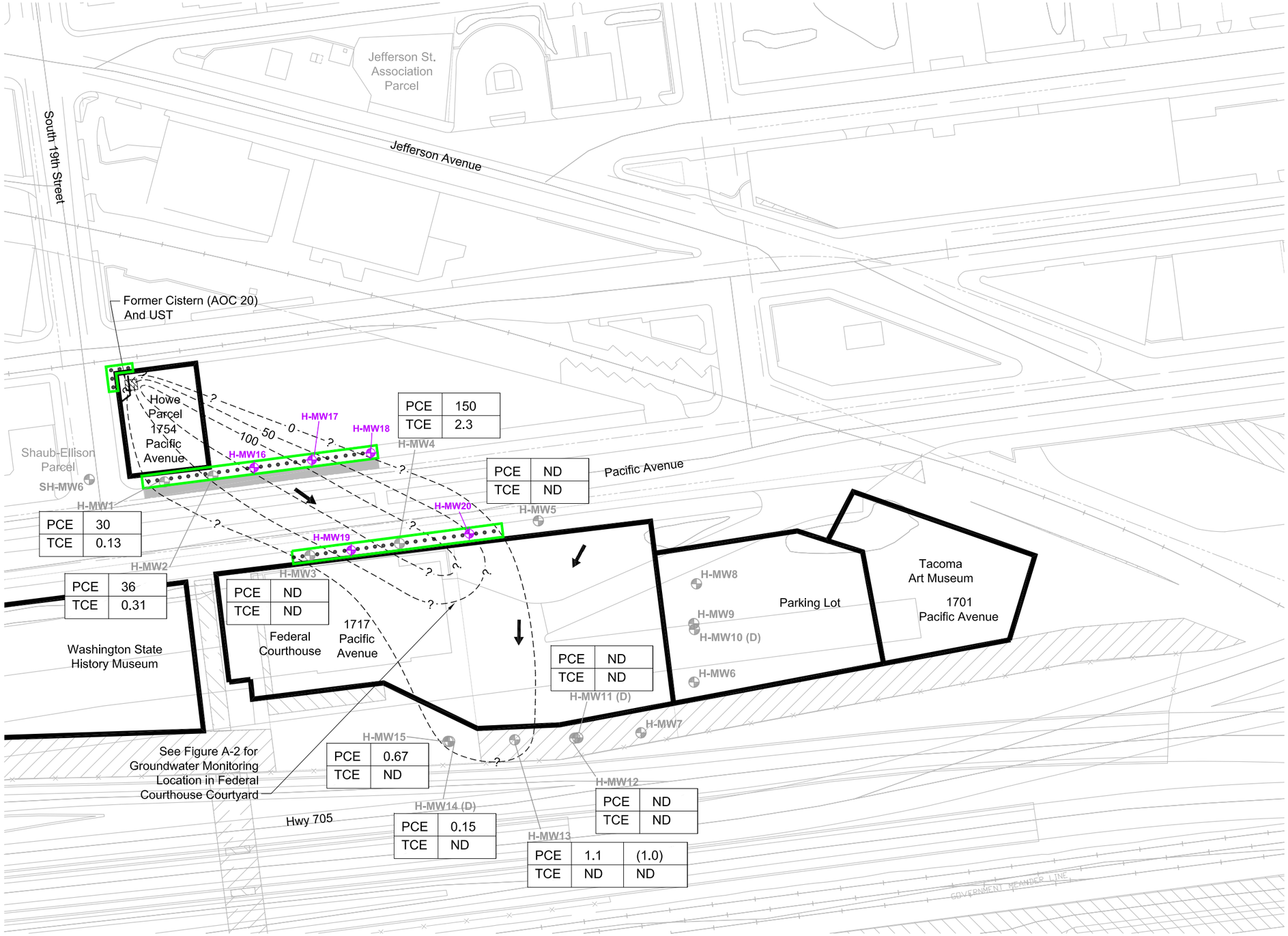

Legend

- Existing Groundwater Monitoring Well
- Proposed Groundwater Monitoring Well
- Proposed Injection Boring/Well (Typ. 10 foot spacings)
- Former AOC or SWMU
- Proposed ERD and ZVI Injection Alignment
- Parking Area

Interpreted Contours of Equal Constituent Concentrations in Groundwater

- PCE Concentration ug/L
- ? Extent Uncertain
- Inferred Groundwater Flow Direction
- 1.71 Concentration in Micrograms Per Liter (ug/L)
- ( ) Duplicate Sample Result
- (ND) Not Detected
- (D) Deep (25') Well Adjacent to Shallow (15') Well
- PCE Tetrachloroethene
- TCE Trichloroethene

Notes:

1. Groundwater sampled 2010.
2. See Figure A-2 for proposed groundwater sampling locations in courtyard of Federal Courthouse building.

0 60 120
SCALE IN FEET

Job No. 33762555

URS P:\ACAD\PROJECT\UW-Tac\Campus\Work Plan\Interim Action\Figure A-1 Insitu.dwg
Mod: 01/30/2012, 15:34 | Plotted: 07/06/2012, 15:23 | john_knobbs

Figure A-1
Injection Point and Monitoring Well Locations
University of Washington Tacoma Campus
Howe Parcel
INTERIM ACTION WORKPLAN

33762555_27.cdr

Key

- Groundwater monitoring location
- –?– Interpreted concentration contour for PCE in groundwater (ug/L) (URS, 2010)
- Areas with regular daily occupancy

0 40 80

Approximate Scale in Feet

Figure A-2

Proposed Groundwater Monitoring Locations
Federal Courthouse, Ground Floor

Job No. 33762555

URS

University of Washington, Tacoma Campus
Tacoma, Washington

APPENDIX B

CALCULATION OF GROUNDWATER CONTAMINANT TRAVEL TIME

Appendix B
Calculation of Groundwater Contaminant Travel Time
University of Washington Tacoma Branch Campus
Howe Parcel – July 2012

Calculate the time required for PCE in groundwater to travel from the sentinel wells on the federal courthouse property to the downgradient property line of the federal courthouse property. Based on this travel time calculation, verify whether or not there should be sufficient time for the UW to implement the contingency actions set forth in the IAWP action to prevent migration of PCE beyond the federal courthouse property.

Assumptions:

1. There is no dilution of PCE groundwater levels between the sentinel wells (represented by well H-MW-14) and the downgradient courthouse property line.
2. There are no preferential pathways between the sentinel wells and the downgradient courthouse property.
3. The values of the below-listed input parameters adequately represent site conditions.

Input Parameters and Values:

Parameter	**Symbol**	**Value**	**Units**	**Source**
Distance from sentinel well to property line	S	30	ft	IAWP, Figure 2-1. Distance measured using Auto Cad software
Fraction of organic carbon	*foc*	0.001	unitless	Assumed value of one tenth of 1-percent
Hydraulic gradient	i	0.025	unitless	IAWP, Section 2.3.2
Hydraulic permeability	K	0.91	ft/day	Based on physical test data, as reported in draft IAAA
Porosity	η	0.26	unitless	Based on physical test data, as reported in draft IAAA
Soil bulk density	ρ_b	1.6	kg/L	Assumed value
Soil organic carbon-water partitioning coefficient	K_{oc}	265	L/kg	Table 747-1, WAC 173-340-900

Calculated Parameters:

Parameter	**Symbol**	**Units**
Distribution coefficient	K_d	L/kg
Groundwater Velocity	V_{gw}	ft/day
PCE Groundwater Migration Velocity	V_{PCE}	ft/day
Retardation factor	R	unitless
Time for PCE to travel from sentinel well to property line	T	days

Appendix B
Calculation of Groundwater Contaminant Travel Time
University of Washington Tacoma Branch Campus
Howe Parcel – July 2012

Equations:

(1) $Kd = foc \times Koc$

(2) $R = 1 + \rho_b \, K_d / \eta$

(3) $V_{gw} = K\, i / \eta$

(4) $V_{PCE} = \dfrac{V_{gw}}{R}$

(5) $T = S/V_{PCE}$

Calculations:

(1) $K_d = 0.001 \times 265 = 0.265$

(2) $R = 1 + 1.6 \times \left(0.265 / 0.25 \right) = 2.7$

(3) $V_{gw} = \left(\dfrac{0.91 \times 0.025}{0.26} \right) = 0.09$

(4) $V_{PCE} = \dfrac{0.09}{2.7} = 0.03$

(5) $T = \dfrac{30}{0.03} = 1{,}000 days \approx 2.7 years$

Conclusions:

The contingency time frames set forth in the IAWP appear to be adequate based on the above calculations.